Transition in the UK coastal bulk trades: 1840-1914

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ABSTRACT

Steam and the screw propeller took a long time to displace sail in coastal bulk trades: 60 years compared with the 20 years needed for steam and the paddle to dominate coastal liner trades. As this thesis confirms, conquering the bulk trades was a much more difficult undertaking. To offset far greater capital and running costs, the developer of the steam bulk carrier could offer only that his steamer, largely independent of weather and tide, would carry significantly more cargo in a given period than a sailing vessel. This thesis demonstrates how, to fulfil this promise, many obstacles had to be overcome, including the high cost of iron hulls and steam engines, the inefficiency of early steam engines and boilers, the water ballast problem, slowness of discharge, archaic port practices, and physical constraints of ports and waterways.

Three phases in the transition to steam in the bulk trades are identified.

During the initial phase, from the 1840s to the mid 1870s, north east coal owners worked with shipbuilders to develop the prototype screw collier. It is shown that a practical method of using water ballast was needed before the screw collier could outperform sailing colliers in carrying coal to London. To have the competitive edge the screw collier needed to make as many voyages as possible, and this required two further changes: the development of mechanised unloading facilities to ensure rapid turn round, and abolition of the 'turn' system whereby a ship, whether sail or steam, was worked strictly in order of its arrival. Only when these limiting factors were overcome could the screw collier offer the dependable

deliveries of coal which the north east coal industry had to guarantee in order to win large contracts from large London coal consumers, especially the gas companies. Although technically successful, the early screw colliers were not economic when judged by the key criterion of earning sufficient to show a profit and meet their replacement costs. It is argued that the early bulk-carrying steamers were effectively subsidised by the coal industry, and largely for this reason they made little impact outside the east coast coal trade during the 1850s and 1860s.

During phase two, from the mid 1870s to 1890, boilers and steam engines were refined so that fuel efficiency increased fourfold, whilst developments in making and using iron and later steel reduced hull costs by up to a third. Once they became cheaper, more efficient and reliable, the steam bulk carriers penetrated additional trades. A rapid increase in employment of steam bulk carriers on the west coast from 1877 is demonstrated. The west coast trade is shown to have required an efficient, smaller, and shallower-drafted ship than the east coast screw colliers, and this type of ship was developed for local owners by shipyards on the English west coast and the Clyde. These yards adopted the technical characteristics of screw colliers and applied recent technological developments. Owners met the high cost of steam compared to sail with a relatively new method of finance, the limited liability, single-ship company.

The technological changes during this second phase also benefited the economics of the east coast collier, as demonstrated by the trend of ownership away from coal interests and towards shipowners. However, the impact of the new technology in this crucial phase of development of an economic bulk carrier is best seen outside the specialised arena of the London coal trade. The most important impact is in trades where the only criterion for adopting steam was the ability to carry cargo more profitably. Take the west coast owners of a wooden ketch delivering a cargo of Cumbrian coal to Belfast each month. They faced no immediate threats in 1877, yet the sudden rise of the steam bulk carrier meant that, within barely a decade, their stark choice was between investment in steam or being squeezed out of business.

The third and last phase, from 1890 to 1914, was one of consolidation as technological progress slowed. Construction costs fell modestly, and efficiency increased largely through the adoption of higher boiler pressures and triple expansion engines. Although such machinery was worthwhile only for the largest coastal vessels, the enthusiasm of west coast owners for steam bulk carriers is shown to be undimmed. Numerically, their fleets are found to have outgrown those on the east coast and, although the ideal ship for their local trades remained small, these owners built larger vessels for east coast trading. Throughout this phase coastal sail slowly and steadily declined. With little scope for sail's competitiveness to be restored, replacing sailing ships was unattractive, and those vessels not wrecked, hulked or sold abroad were sentenced to working in minor trades unappealing to the steamship owner.

The findings suggest that, in the rise of the steam bulk carrier, the role assigned to railways should be diminished, and that of the gas industry accentuated. The impact of rail competition on the London collier trade was no more than a pinprick when the first screw collier was building, and the coal market's subsequent growth was so strong that the steady increase in rail-hauled coal barely dented the tonnage delivered by sea from the north east. On the other hand, without the gas industry's demand for large, regular and guaranteed deliveries, the coal interests would probably not have encouraged the development of the screw collier when they did.

As a further piece of revisionism, the view is challenged that the *John Bowes* was the forerunner of the 'coaster' as Waine describes all steam bulk carriers not confined to the east coast coal trade.[1] Technical features were certainly copied: iron hull, screw, steam engine and water ballast, but the west coast yards built smaller and notably shallower hulls to suit local conditions. With the tendency for ships to grow bigger, not smaller, the *John Bowes* was more the progenitor of the ocean tramp steamer and its successor the modern bulk carrier than the coaster.

1. Waine, C.V. and Fenton, R.S., *Steam Coasters and Short Sea Traders* (3rd ed. Albrighton, 1994)

CHAPTER ONE: INTRODUCTION AND ACKNOWLEDGEMENTS

Aims of the research

During the latter part of the nineteenth century and up until the First World War, coastal shipping carried a significant proportion of the United Kingdom's internal trade. In terms of ton-miles of goods carried, coastal shipping eclipsed railways and canals combined, carrying almost 60% of the goods moving between United Kingdom destinations in 1910.[2] As will be argued in chapter two of this thesis, materials carried in bulk such as coal, ore, stone and grain comprised more than half, and perhaps as much as two thirds, of the total coastal trade. During the period from 1840 to the outbreak of the First World War coastal bulk carrying saw the gradual transition from the sailing ship to the steamship. This transition is of considerable economic significance, not only because of the extent of coastal bulk shipping, but also because the steamers developed for coastal use were quickly enlarged for the deep-sea bulk carrying, which the steam tramps of the British shipping industry came to dominate. Despite its significance, the process of change from sail to steam in the coastal bulk trades has been neglected by shipping and economic historians, a theme which is expanded in the literature review in chapter two.

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2. Armstrong, J., 'The Role of Coastal Shipping in UK Transport: an Estimate of Comparative Traffic Movements in 1910'. *Journal of Transport History*, 1987; VIII, No.2: 164-78.

This thesis begins from the impression that this transition from sail to steam did not occur evenly. The east coast adopted steam for bulk cargoes relatively quickly from the 1850s onwards, a development examined in chapter 3. However, there is little evidence that steam ships penetrated west coast/Irish Sea bulk shipping before 1877. It is therefore hypothesised that steamers did not make a significant impact in the west coast bulk trades for some 25 to 30 years after they had begun to be established on the east coast equivalents.

The aim of this research is, firstly, to quantify the use of steamships in the east and west coast bulk trades to support or refute the above hypothesis. This work is the subject of chapter 4 (1850-1870) and chapter 5 (1870-1910). The second and broader objective of the research is to achieve a better understanding of when and particularly how the change from sail to steam occurred in coastal bulk shipping. To achieve these aims the following factors that may account for differences between the coasts are examined.

Chapter 6 explores whether the geography of the bulk trades, including volumes of cargo flowing and port practices, explains the differences between the uptake of steam on the two coasts.

Chapter 7 analyses ownership patterns of steamships that may explain the differences in the adoption of steam between the two coasts.

Chapter 8 considers how shipping finance and management needed to develop to cope with the specific requirements of the steamship, and asks whether these developments were uneven between the two coasts.

Chapter 9 examines whether the steam bulk carriers which developed on the east coast and on the west coast were distinct species of vessel and if so did one evolve from the other, or were there different evolutionary processes.

Chapter 10 reviews developments in the technology of shipbuilding and marine engineering during the three decades after 1850 which may have encouraged the spread of steam bulk carriers.

Chapter 11 considers how commercial factors such as competition from the developing rail network or demand from important customers affected the adoption of steam.

In conclusion, chapter 12 pulls the strands together to suggest how steam displaced sail in the coastal bulk trades, and to draw some inferences on the wider process of steam substitution. It explores the broader economic and social consequences of the change, including the effect on extractive and manufacturing industries dependent on coastal shipping, changes in shipping and port industries consequent upon the use of steam, the development of shipbuilding and marine engineering, and how developments in coastal shipping spread to the deep-sea bulk trades. Lastly, it considers how the methods used during the research may usefully be applied to researching other aspects of shipping history.

Appendix 2 is presented on CD-ROM and includes data which was used as a basis for much of the research and details all known screw steamers engaged in bulk trades from 1840 to 1880.

A note on nomenclature

During six years' endeavour, no better term has been found to describe the ships which are the subjects of this thesis than the clumsy 'coastal steam bulk carrier', sometimes shortened to 'steam bulker'. The term 'steam coaster' is used by Waine who has contributed much to their study, but is too imprecise in that 'coasters' served both liner and bulk trades. Contemporary written sources refer to 'screw colliers', a concise term which has been used for the early east coast vessels, as much for its contemporary resonance as to provide variety.

Acknowledgements

Although not wishing to belittle the contribution of my academic tutors, my first acknowledgement is to my wife Heather, who not only encouraged me in my desire to begin this thesis, but provided support at every stage, and did not demur at (indeed, often made the sandwiches for) my repeated absences in libraries and on research expeditions.

Professor John Armstrong of Thames Valley University was a natural choice as supervisor as the only known academic with a deep interest in coastal shipping. He proved a very sound selection; not only wise about the literature, but also the ways of those who award degrees. His unfailing interest, support and friendship plus gentle reminders about progress have in large measure contributed to my completing this thesis.

My external supervisor, Professor Sarah Palmer of Greenwich Maritime Institute, has complemented John's close-in support with very useful offshore coverage, not least in encouraging me to embrace concepts such as contrafactualism, revisionism and contextualisation which, once I had looked them up, contributed greatly to the finished result.

Robin Craig is thanked for steering me towards appropriate supervisors, and for helping develop the title of this thesis.

I am grateful for a grant from the Tomlin Fund of the Society for Nautical Research which made possible visits to the National Archives, Dublin and the Public Record Office of Northern Ireland, Belfast.

The librarians and curators of archives to whom I owe thanks are too numerous to record, and include those from the British Library, Cumbria Record Offices at Carlisle and Whitehaven, the Guildhall Library, the House of Commons Library, the House of Lords Record Office, the Institute of Historical Research, Lloyd's Register, the London School of Economics, the National Archives (Ireland), the National Archives (United Kingdom), the National Maritime Museum, the Public Record Office of Northern Ireland, and Tyne and Wear Archives.

Gratefully acknowledged is use of books and records accumulated by the World Ship Society; a database of British-built ships, part of the British Shipbuilding History Project, kindly supplied by Dr. Ian Buxton; and a database of

British steamers compiled from Returns of Registered Steam Vessels of UK by Mr. P.N Thomas.

Lastly, I thank my friends for their, often unwitting, help. In particular this includes members of the World Ship Society who encouraged my interest in old coal boats, tutored me in the arcane ways of shipping research, and looked kindly on my occasional contributions to the literature.

CHAPTER TWO: COASTAL SHIPPING UNDER STEAM - A REVIEW OF THE LITERATURE

Introduction: a blank slate

Coastal shipping has been of enormous importance to the British economy, in supplying raw materials for other industries and distributing their produce, and in providing gainful employment for both labour and capital. However, compared with deep-sea shipping, it has been neglected by historians. Armstrong has described our knowledge of coastal shipping as '...a largely blank slate on which a few words have been written faintly.'[1] For the coastal bulk trades the words on the slate are particularly faint, yet these bulk trades outweighed the liner trades in importance.[2]

In the period under review (1850 to 1914) the coastal bulk trades underwent a revolution in which small, wooden-hulled, wind-driven vessels were replaced by larger, iron- and later steel-hulled ships propelled by screws driven by steam engines. This revolution was as profound as the container revolution of the 1960s and 1970s in the far-reaching technical, operational, manning and managerial changes it brought to the shipping industry as a whole.[3] The revolution was embraced by deep-sea shipping, so that the bulk carrier of today - although much larger and more sophisticated - is not fundamentally different in concept from the pioneer screw collier of the early 1850s.

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1. Armstrong J., Cutler J., and Mustoe G., 'An estimate of the importance of the British Coastal liner trade in the early twentieth century'. *International Journal of Maritime History,* 1998; X, No.2: 41-63.
2. Armstrong J., Cutler J, and Mustoe G., and Armstrong, J., 'The role of Coastal Shipping in UK Transport: an Estimate of Comparative Traffic Movements in 1910'. *Journal of Transport History*, 1987; **VIII**, No.2: 164-78. These papers are considered in more detail later.
3. See the introduction by Greenhill, B. to: Corlett, E. *The Ship: the Revolution in Merchant Shipping 1950-1980* (London, 1981).

Yet only a handful of authors have concerned themselves with the coastal bulk trade and its revolution in the latter half of the nineteenth century.[4]

This chapter reviews the words faintly written on Armstrong's slate, and identifies areas where our knowledge of coastal bulk shipping could be usefully enlarged. It begins by attempting to define what is meant by coastal shipping in the British context, and looks at its economic and industrial significance. It then considers the transition to steam in coastal shipping and how this led to specialisation, with the separate development of liner trade shipping and bulk carrying. Contributions to both the academic and to the more prolific enthusiast press are considered, not only because of the paucity of the former but also because enthusiast-authors such as Waine[5] have made significant contributions to the study of bulk carrying coastal steamers, by classifying them in terms of size and specialisation, tracing their early evolution, and outlining the histories of their principal owners. As coastal tramp shipping has received very little attention, the (again sparse) literature on deep-sea tramp shipping has been included in the review, although it has to be read with caution as to the relevance of its findings to the coastal sector.

What is meant by coastal shipping in the British context

Any definition of British coastal shipping must take into account that coasters had to be capable of routinely making short-sea crossings, for instance from the British mainland to Ireland, and navigating in waters such as those north and west of Ireland

4. See, for instance, Armstrong, J., 'An annotated bibliography of the British Coastal Trade'. *International Journal of Maritime History*, 1995; VII, No.1: 117-192.
5. Waine's work covers the three major types of British coastal steamer: the coastal bulk traders in general in Waine, C.V. and Fenton, R.S.. *Steam Coasters and Short Sea Traders* 3rd edition, (Albrighton, 1994); the specialised coastal colliers in Macrae, J.A. and Waine, C.V., *The Steam Collier Fleets* (Albrighton, 1990); and the liner trade vessels in Waine, C.V., *Coastal and Short Sea Liners* (Albrighton, 1999).

and Scotland which were exposed to the full force of Atlantic gales. In the British context a direct voyage between two ports on the mainland, say from Barrow to Cardiff with iron ore, could entail an open sea passage exposed to no less a danger than a voyage from the Mersey to Dublin with domestic coal. On the North Sea, a purely coastal voyage with Tyne coal down the east coast and up Channel to Plymouth could be more arduous than delivering a similar cargo to Antwerp or Rouen.

The similarity of conditions in immediate UK coastal waters, off the west coast of the UK, in the English Channel and the southern North Sea was recognised by the Merchant Shipping Act of 1854, which defined 'Home Trade Limits' as stretching from Brest to the Elbe.[6] This definition was made, essentially, to cover manning, and to set various limits on the number and paper qualifications of the crew, for instance allowing uncertificated officers on ships trading within Home Trade Limits.

Voyages between certain British ports could be made purely within sheltered waters, for instance between Manchester and Liverpool, Goole and Hull, Gloucester and Bristol. As far as possible, this traffic has been excluded from consideration in this thesis, as it often involved vessels which were not sufficiently large or seaworthy to be considered capable of voyages in the open sea. The problem of the definition of sheltered waters immediately arises, however, as the Bristol Channel and the Firth of Clyde, exposed to prevailing westerly winds, can be as hazardous as the adjoining open sea. The Merchant Shipping Act of 1894, which consolidated much existing legislation, is silent on this matter.[7] For the purpose of this thesis, the Bristol Channel

6. 17 and 18 Vict. c. 104. The Merchant Shipping Act, 1854.
7. 57 and 58 Vict. c. 60. The Merchant Shipping Act, 1894.

below Bristol, and the Firth of Clyde below Bute are considered as being 'coastal' rather than 'sheltered' waters.[8]

One distorted definition of coastal shipping must also be mentioned, although it can be rapidly dismissed. Countries which reserved coastal trading to ships flying their national flag, including United States, Russia and France, extended the definition of 'coastal' to include traffic to distant possessions, so that a voyage from Marseilles to Saigon would come under the definition of 'coastal trade'.[9] Despite the enormous potential for voyages between British possessions, this definition was never applied by Great Britain within the period under review.

For the purposes of this thesis then, the British coastal trade is considered to include all cargoes carried between two British 'home' ports separated by a stretch of open sea, that is all those in England, Wales, Scotland, Ireland (including outlying islands, such as the Orkneys, Shetlands, Hebrides), the Isle of Man and the Channel Isles.

Given the extreme weather conditions likely to be encountered within Home Trade Limits, the vessels engaged in the coastal trade were soundly built. Hence, they were by no means confined to the waters as just defined, and many cases are found of them undertaking voyages to the Baltic, Mediterranean and even farther afield. Armstrong has commented on how such flexible deployment makes it difficult to

8. The second of these limits was recognised by owners and builders of Clyde puffers. According to Waine and Fenton vessels of this type which ventured beyond the 'shorehead limit', a line drawn between Garroch Head on Bute and Skipness on Kintyre, were required to have a loadline and observe other requirements for seaworthiness, including bulwarks, hatch coamings and covers, and increased freeboard. Waine, C.V. and Fenton, R.S., chapter 5.
9. Fayle, C.E., *A Short History of the World's Shipping* (London, 1933), page 273.

determine what constitutes a coastal ship.[10] It is indeed almost impossible to define a 'coaster' by its build, and the classification of a particular vessel as a coastal trader depends largely on determining the trade in which it is involved at a given time.

The importance of coastal shipping in the nineteenth century

It has been strongly argued that economic historians have seriously underestimated the importance of coastal shipping[11] which made a significant contribution to the development of many industries during the industrial revolution, including coal mining, iron, gas, tin and copper mining, china clay and pottery, building, and agriculture.[12]

Whilst the overall contribution of coastal shipping to economic activity is difficult to quantify, its importance to the internal trade of the British Isles has been assessed by comparing the work done by coastal shipping, railways and canals in 1910.[13] In this year, coastal shipping carried just 24 per cent of the tonnage carried by railways, but this was carried, on average, over six times further. As a result, the work done by coastal shipping in terms of ton-miles considerably exceeded that done by railways and canals combined (table 2.1). The 59 per cent contribution of coastal shipping to the medium- and long-distance carriage of freight leaves no doubt as to the significance of this mode of transport to Britain's internal trade in the years just before the First World War.

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10. Armstrong, J., 'Introduction: the Cinderella of the transport world: the historiography of the British coastal trade.' In Armstrong J. ed *Coastal and Short Sea Shipping* (Aldershot, 1996).
11. Armstrong, J., 'Introduction: the Cinderella of the transport world: the historiography of the British coastal trade.'
12. Armstrong, J. and Bagwell, P.S., 'Coastal Shipping' in Aldcroft D.H. and Freeman M.J., *Transport in the Industrial Revolution* (Manchester 1983), pages 168-70.
13. Armstrong, J., 'The Role of Coastal Shipping in UK Transport: an Estimate of Comparative Traffic Movements in 1910'. *Journal of Transport History*, 1987; VIII, No.2: 164-78.

Table 2.1: Work done by coastal shipping, railways and canals in 1910

Source: Armstrong, J. 'The role of Coastal Shipping in UK Transport: an Estimate of Comparative Traffic Movements in 1910'. *Journal of Transport History*, 1987; **VIII**, No.2: 164-78.

Transport mode	Tonnage carried	Average length of haul (statute miles)	Ton-miles of work	%age of total
Coastal shipping	81,528,640	251.7	20,393,111,365	59%
Railways	336,332,800	40.0	13,453,312,000	39%
Canals	39,500,000	17.5	691,250,000	2%

The sources both for tonnages carried and average lengths of haul for the three modes of transport are disparate. Nevertheless, the figures - which have not been challenged in the published literature - help to correct the impression given by the sheer weight of historical research into rail transport that coastal shipping was eclipsed by the coming of railways. Indeed, far from declining, coastal shipping expanded during the period 1840 to 1914 when railways were growing to the zenith of their power. The tonnage of ships entering British ports coastwise between 1830 and 1914 saw an annual compound growth rate of 1.5 per cent.[14] Annual growth in coastal coal shipments was even stronger over this period at 2 per cent, yearly totals increasing from 5.8 million tons in 1833 to 22.9 million tons in 1913. The numbers of ships involved in the coastal trade are also impressive: in 1892 there were 206,000 entrances in the coastal trade, representing a total of 29,100,000 registered tons of shipping.[15] By 1913 the number of entrances had fallen to 169,000, but the figure for registered tonnage had

14. Armstrong, J., 'Coastal Shipping: the Neglected Sector of Nineteenth-Century British Transport History'. *International Journal of Maritime History*, 1994; VI, No. 1: 175-88

grown to 34,800,000, reflecting the displacement of small, coastal sailing ships by larger steamers. By its very nature the coastal trade involved short, relatively frequent voyages, and the above figures represent the same ship entering a port many times in the course of a year. Nevertheless, if each vessel in the coastal trade entered two UK ports each week on average during 1913, a huge total of 1,700 individual vessels was involved.

A further measure of the importance of coastal shipping is the extensive network of coastal liner routes which existed.[16] The strength of this network is attested by the readiness with which coastal shipping's erstwhile competitors, the railway companies, agreed to collude over freight rates and arrangements for pooling cargoes.[17] It has been pointed out that the coaster linked the regions of the UK into something of a national economy.[18] The liners tended to carry the more valuable manufactured or semi-manufactured goods, as well as foodstuffs and cattle.[19] Meanwhile, coastal bulk carriers handled bulkier, lower value cargoes, especially coal but also including raw materials including metal ores, stone, china clay, and grain.[20]

A second measure of the importance of coastal shipping is the proportion of overall British shipping activity it represented. Total shipping activity was immense: between 1870 and 1910 Britain owned around a third of the world's shipping tonnage, in 1910 it had 41.5 per cent of its steam tonnage, and carried no less than 52 per cent

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15. Armstrong, J., 'Climax and climacteric: the British coastal trade, 1870-1930'. In: Starkey, D.J. and Jamieson, A.G. eds. *Exploiting the sea: aspects of Britain's maritime economy since 1870*. (Exeter, 1998), pages 37-58.
16. Armstrong J, Cutler J, and Mustoe G., page 38.
17. Armstrong, J., 'Management response in British coastal shipping companies to railway competition.' *The Northern Mariner* 1997; VII: 17-28.
18. Armstrong, J., 'Management response in British coastal shipping companies to railway competition.'
19. Armstrong J, Cutler J, and Mustoe G., page 49.
20. Armstrong J, Cutler J, and Mustoe G., page 49.

of the world's traffic.[21] In the period 1824-30, just before that under review, the coastal trade accounted for over 75 per cent of tonnage entering British ports.[22] Aldcroft considers that the preponderance of coastal over ocean shipping continued until the 1890s.[23] The change in the 1890s seems to have been caused by the faster growth rate of ocean shipping, as the tonnage of cargo shipped coastally continued to increase year on year until the massive disruption caused by the First World War.[24]

As a significant sector of the shipping industry, coastal shipping was also important as an employer of both labour and capital. There is evidence that employment in one important arm of coastal shipping, the east coast coal trade, may have offered advantages over employment in deep-sea shipping. In steam colliers in the east coast coal trade between 1870 and 1914 payment was universally at a weekly rate, in contrast with the rate per voyage which appears to have been the prevailing method in sailing colliers.[25] Both methods of payment had advantages for the respective owners. Paying a per voyage rate on the sailing ship, whose length of voyage was unpredictable, helped the owner contain his costs by making the crew take a proportion of the risk of a voyage. On the other hand, in the screw collier the voyages were to a large extent predictable, and the owner was interested in continuity of employment partly so that turnround times in ports could be kept to a minimum. The weekly wage meant that productivity improvements, achieved for instance by

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21. Pollard, S., 'Shipping and the British economy since 1870.' In: Starkey D.J. and Jamieson A.G. eds. *Exploiting the sea: aspects of Britain's maritime economy since 1870* (Exeter, 1998), pages 37-58.
22. Armstrong, J. and Bagwell, P.S., page 148.
23. Aldcroft, D.H., 'The Eclipse of British Coastal Shipping, 1913-21.' *Journal of Transport History*, 1963; **VI**: 24-38. Reprinted in Armstrong, J. ed. *Coastal and Short Sea Shipping* (Aldershot, 1996). Aldcroft gives as his sources Hoffman, W.G., *British Industry* 1700-1850 (trans. by Henderson W.O. and Chaloner W.H., 1955); and Fuchs, C.J., *The Trade Policy of Great Britain and her Colonies since 1860*, 1905, 121-4.
24. Armstrong, J., 'Coastal Shipping: the Neglected Sector of Nineteenth-Century British Transport History'.
25. Armstrong, J., 'The crewing of British coastal colliers: 1870-1914' *The Great Circle* 1998; 20 (2), 73-89.

making more voyages in a given period, were passed on to the owner. The wages paid to able seamen and to firemen were similar and were remarkably constant over the period, with some variation from ship to ship but averaging £1.48 per week. Contrasting these wage rates with those in deep-sea shipping, and making due allowance for the crew of colliers having to provide their own provisions, the coastal collier sailor was better paid than his deep-sea counterpart. The age distribution of crew members suggests that going to sea in coastal colliers was regarded as a career in its own right, countering suggestions that it was 'a nursery for seamen' or the resort of older men who had gone deep-sea in their younger days. Desertion rates were low at 3.6 per cent overall, and this can be contrasted with figures of 9 per cent and 16 per cent for British deep-sea steam and sailing ships. It was quite usual for crew members to take one or more voyages off (indeed, such facility would reduce the tendency for desertion) later returning to their same position which had been covered temporarily, in the case of petty officers or officers, by a temporary promotion from a lower rank. A minor criticism of this work is that the author suggests such absence might be due to sitting for an examination, whereas most officers in the Home Trade were uncertificated. Although several accounts have been written about life aboard sailing coasters, there are just two known descriptions of life at sea by men who served on steam coasters in various capacities – a seaman in one case, and a seaman, mate and master in the other.[26] These accounts mainly cover the period between the First and Second World Wars, when shipping was seriously depressed, but suggest that for a man who was to settle for such a life it did provide employment that was

26. Spargo, O.G. and Thomason, T.H., *Old Time Steam Coasting* (Albrighton, 1982).

more varied and interesting than that on land, but not as detached from home as the life on a deep sea vessel. Significantly, coastal shipping provided a career whereby a man with only a rudimentary education could, with application, progress from seaman to mate and to master, and from there – with a modest capital, good connections and good luck – to successful shipowner. The writer has found several such examples amongst the coastal shipowners of Liverpool.[27]

Coastal shipping has provided a nursery for major technical developments. Steam itself was first applied to transportation by water with such vessels as the *Comet*, operating on the Clyde in 1812.[28] The first sea-going iron ship is claimed to be the *Rainbow* of 1837, built at Birkenhead for the General Steam Navigation Company, and which ran between London and Ramsgate and later from London to Antwerp and Rotterdam. The screw propeller was developed from about 1837, and one was fitted to the wooden steamer *Archimedes,* launched on the Thames in 1838 for the coastal trade. Improvements in boilers were also first adopted in coastal ships, including use of higher pressures, the water tube boiler, and forced draught. Surface condensers in place of the cruder jet condensers were first used in coastal ships.[29] The gradual improvements to the design of marine propelling machinery saw side-lever engines give way to 'steeple', oscillating, return piston-rod, and the diagonal engine. Compounding, introduced by John Elder in the 1850s, was first applied to a coastal ship, the *Bandon* of 1854 but, although Elder also took out patents for triple- and

27. Fenton, R.S., *Mersey Rovers* (Gravesend, 1997)
28. Bruce, J.G., 'The contribution of cross-channel and coastal vessels to developments in marine practice.' *Journal of Transport History*, 1959, **IV**, No.2, 65-80.
29. Palmer, S., 'Experience, experiment and economics: factors in the construction of early merchant steamships' in: Matthews K and Panting G eds. *Ships and Shipbuilding in the North Atlantic Region* (St. John's, Newfoundland, 1978), pages 209-30.

quadruple-expansion engines, triple-expansion machinery was first fitted to a steamer on the Seine by the French engineer Normand in 1850. Improvements in navigating techniques and stability also owe their first use to coastal vessels, in both cases built on the Clyde. The West Highland steamer *Mountaineer* of 1852 had the first engine room telegraph, whilst the disaster which occurred when the short-sea steamer *Daphne* capsized on launching at Linthouse in 1883 led to the practice of stability calculations being made for each individual vessel before launching.

Bruce offers two suggestions as to why innovations in ship construction and naval engineering were concentrated in coastal ships. Firstly, if an innovation failed the loss was likely to be less catastrophic in a small vessel than in a larger one. This seems reasonable, but taken to its conclusion it should mean that vessels even smaller than the coaster, namely river vessels, should be the objects of experimentation. Perhaps more convincing is Bruce's suggestion that competition amongst coastal shipowners was sufficient to encourage experimentation where the gaining of speed, reduced turnround times, extra reliability or increased stability could give a commercial advantage. However, Palmer's opinions on this point diverge from those of Bruce.[30] Whilst agreeing that competition in the coastal liner trade was severe, even cut-throat, her detailed examination of records of early steamship companies leads to her to the conclusion that, although eager to derive benefit from improvements, most shipowners were not keen to be the first to try them. She observes that owners often attempted to obtain greater speed by developing existing technology rather than adopting the new. For instance, as late as 1850 the most

30. Palmer, S., pages 209-30.

popular form of machinery was the side-lever engine, essentially unchanged since its development by James Watt.

It is concluded that, in the period under review, coastal shipping had a share of the internal trade of the British Isles which was at least as great as that of the railways. Coastal shipping activity grew consistently over the period, and technical developments led to an improvement in productivity. The contribution of coastal shipping to moving the coal and raw materials required by industry and domestic consumers was great, but important quantities of foodstuffs and manufactured and other high-value goods also moved by coastal steamer. Coastal shipping represented at least half of all British shipping activity up until 1890, after which the growth of deep-sea shipping accelerated. The coastal trade represented a major employment opportunity for seamen, and evidence from the east coast coal trade suggests this employment was both regular and better remunerated than going deep sea. Coastal steamships also saw the first use of many technological innovations in hull design, boiler and marine engineering technology.

The transition from sail to steam in coastal shipping

Authors writing about the early development of the steamship concur that it took place almost exclusively within the coastal trade.[31] Although there is still dispute about quite which steamers pioneered which routes and when, the development of the steamer up to the mid-nineteenth century in the liner trades has been well covered, and

31. Kennedy, J., *The History of Steam Navigation* (Liverpool, 1904). This book is remarkable for the attention it gives to coastal companies, albeit almost only those in the liner trades, and devotes alternate chapters to these and to far grander ocean liner companies.

this section concentrates on the introduction of steam to the bulk trades, a Cinderella subject in comparison.[32]

The steam engine was used successfully for water transport before it was employed to propel land vehicles. In a remarkably well-researched but obscure book, Kennedy recorded his painstaking attempts to trace all recorded British steamships.[33] His first record - albeit a very sketchy one - dates from 1704, and he lists ten further examples from the eighteenth century. Kennedy is at one with other authors in admitting the *Comet* of 1812 as the first practical steamer in the United Kingdom.[34] However, he is in no doubt that the vessel credited with having the first iron hull, the *Aaron Manby* of 1822, is an impostor, and awards this distinction to Symington's *Experiment* of 1788.

The years immediately following the success of the *Comet* saw further pioneering voyages along coasts and across exposed waters which established the viability of the steamship.[35] Between 1819 and 1825 a number of regular steamer services were established on estuarial, coastal and short sea routes, one of the most distinguished providers of these being the General Steam Navigation Company formed in 1824.[36] However, despite technical progress on the Clyde and the Thames, the marine steam engine remained an extremely inefficient prime mover and it was

32. Greenhill, B., (ed) *The Advent of Steam: the Merchant Steamship before 1900;* (London, 1993). This recent book, part of a series promoted as 'the first detailed and comprehensive account' of the ship, exemplifies both the scholarship that has gone into the historiography of the early steamship, and the neglect of the later development of steam in the coastal bulk trades. Greenhill's early chapter on the paddle steamer gives coastal shipping its due, but subsequent chapters on the screw and triple expansion machinery ignore the coastal and ocean tramp trades completely in favour of passenger and cargo liners, masterfully mistaking the grandiose for the important.
33. Kennedy, N.W., *Records of Early British Steamships* (Liverpool, 1933).
34. For instance, Hope, R., *A New History of British Shipping* (London, 1990), pages 266-7; Kennedy, J., page 34; and Palmer, S., page 233.
35. Hope, R., pages 266-7.

only on short routes and with coal readily available that steamers could operate successfully. These services catered for passengers, who would pay a high price for the dependability and speed of a steam packet, for small quantities of high-value goods such as mails, and for perishable cargoes such as livestock. As a result, even by the 1850s steamships represented only a small proportion of the total British merchant fleet: just 2 per cent of the ships in the 1853 *Lloyd's Register* were steamers according to Greenhill.[37] At this period, *Lloyd's Register* concentrated on vessels which were classified by the Society, and this may reflect the bias against iron-hulled vessels (which included most steamers) which drove the Liverpool underwriters to set up their own register.[38] Palmer gives a much higher figure noting that, of 1,218 vessels on the British register in 1852, 247 (20 per cent) were steamers.[39] Perhaps this underestimates the importance of steam to the coastal trade, however, as even by 1830, steamships represented 10 per cent of the entries by tonnage in the coastal trade.[40]

The inherent drawbacks of the early steamer meant the continued preponderance of sailing ships in the bulk cargo trades during the mid-nineteenth century. The disadvantages of the steamer included its high cost of construction, and the space which needed to be dedicated to the engines, boilers, and bunkers.[41] Added to these were the cost of the coal and the wages of firemen and engineers who were needed in addition to the hands required to navigate the vessel and handle the sails

36. Hope, R., pages 266-7; Kennedy, J.; page 34; and Rowland, K.T., *Steam at Sea: A History of Steam Navigation* (Newton Abbot, 1970), page 59.
37. Greenhill, B. 'Steam before the screw' in Greenhill, B. (ed.), *The Advent of Steam: The Merchant Steamship before 1900* (London, 1993)
38. Anonymous *Annals of Lloyd's Register* (London, 1934).
39. Palmer, S., page 233.
40. Armstrong, J. and Bagwell P.S., pages 145-6.

(contemporary illustrations and models show that pioneer steamers carried a full suit of sails). Use of paddle wheels for propulsion did not favour cargo carrying, as the engines had to be placed amidships and high up in the most useful part of the hull for cargo,[42] whilst paddle propulsion was not suited to the variations in draft consequent upon the bulk carrier's need to sail in both loaded and unloaded conditions. These factors meant that low-value bulk commodities - and in particular coal, stone and ore, but also grain and timber - continued to be carried by sailing ships on the coast and on short-sea routes.

The potential benefit of using a steamer in the bulk trades was that it was faster on average than a sailing vessel and - most important - it was almost independent of wind and tide so that it could make more passages in a given period and hence carry more cargo in a given period than a sailing ship. Given favourable circumstances, the additional earnings would be sufficient to offset the steamer's higher capital, crew and fuel costs and hence provide a profit. The 1840s saw a number of well-documented attempts to exploit this advantage of the steamer. On the Tyne in 1841 the *Bedlington* was built to carry railway trucks of coal between Blyth and South Shields, but after initial success failed because of high repair costs.[43] The *QED* built at Walker-on-Tyne in 1844 made at least one voyage to London with coal,[44] but within two years her engines had been removed.[45]

41. Hope, R., page 267.
42. Bruce, J.G., page 6.
43. Martin, S.B. and McCord, N., 'The Steamship *Bedlington*, 1841-54'. *Maritime History*, 1971, **1**, No. 1, 46-72
44. *Illustrated London News* 28th September 1844.
45. Craig, R., 'Aspects of tramp shipping and ownership', in: Matthews, K. and Panting, G. eds. *Ships and Shipbuilding in the North Atlantic Region*. (St. John's, Newfoundland, 1978), page 214.

In an 1863 paper, the shipbuilder Charles Palmer asserted that the impetus for developing the iron collier came from railway competition to the sailing collier, competition which meant that, by 1850, rail carriage of coal began to seriously affect sale of north-country coal in London.[46] Following *Bedlington* and *QED*, further screw steamers were built in the north east of England (*Experiment* of 1845, *Conside* of 1847), at Waterford (*Neptune* of 1847),[47] and on the Clyde (*Collier* of 1848).[48] Generally accepted as the most successful early screw collier was the *John Bowes* of 1852, built by the Palmer Brother's newly-set up Jarrow yard.[49] Launched on 30th June 1852, *John Bowes* set out from the north east on her first voyage on 27th July, unloaded 500 tons of coal in the Thames and returned to the Tyne on 3rd August. It was claimed that in one week the *John Bowes* had done the work which would normally take two collier brigs a month.[50]

The iron hull and steam-driven screw propeller of the *John Bowes* were not particularly innovative, and perhaps her most significant feature was a single 60-foot hatch which allowed coal to be teemed very easily into all parts of the hold, greatly reducing the trimming needed[51] and discharge.[52] However, the development which was probably of most significance in ensuring the commercial success of the early screw colliers was an arrangement for carrying water ballast.[53] Loading water as

46. Palmer, C.M., 'On the construction of iron ships and the progress of iron shipbuilding on the Tyne, Wear and Tees.' *Report of the British Association for the Advancement of Science for 1863*, pages 694-701.
47. Macrae, J.A. and Waine, C.V., page 12.
48. Craig, R., *The Ship: Steam Tramps and Cargo Liners 1850-1950* (London, 1980), page 6.
49. Craig, R., *The Ship: Steam Tramps and Cargo Liners 1850-1950*, page 7.
50. This figure is widely quoted and probably originates with Charles Palmer; see for instance Macrae, J.A. and Waine, C.V., page 13; Craig, R., 'Aspects of tramp shipping and ownership' pages 209-30; and Bowen, F.C., (writing as 'FCB') *Shipbuilding and Shipping Record*, 30th September 1937.
51. Macrae, J.A. and Waine, C.V., page 13.
52. Craig, R., 'Aspects of tramp shipping and ownership', page 222.
53. Craig, R., *The Ship: Steam Tramps and Cargo Liners 1850-1950*, page 5; Macrae, J.A. and Waine, C.V., page 12.

ballast saved the time and cost of queuing for and loading shingle or chalk ballast for the unladen return voyage and of unloading this ballast on return to the coal port. A number of methods for carrying water ballast were tried, including barrels in the hold and canvas bags, but ultimately the most successful were McIntyre tanks fitted between the bottom of the hull and the floor of the hold, with transverse and longitudinal partitions (the former the frames of the ship) to prevent surging.[54] The tanks were filled and emptied by pumps working off the main engine. The evolution of water ballast arrangements are discussed in detail in chapter 3.

Following the *John Bowes*, expansion of the east coast steam collier fleet was initially rapid and 36 colliers had been completed and entered service by February 1855.[55] However, there were dissenting voices. In the discussion to Allen's paper, Ralph Jackson - who had interests in both the port facilities and shipping at West Hartlepool - referred to his Liverpool-built *Hunwick* of 1852. Jackson claimed that after a trial of four years (an exaggeration, as she was only 27 months old when Allen's paper was discussed) he had found it so unprofitable to run her in the coal trade that he switched her to the general cargo trade to Hamburg.[56] Jackson believed that Allen had underestimated both the costs of steam ships and the work that sailing vessels could do, and his experience of both steam and sailing colliers convinced him the latter was more profitable. Neither was the General Iron Screw Collier Co. Ltd. totally convinced by its decision to operate colliers: after building at least ten vessels

54. Craig, R., *The Ship: Steam Tramps and Cargo Liners 1850-1950*; Bowen, F.C., (writing as 'FCB') *Shipbuilding and Shipping Record*, 30th September 1937; Waine, C.V. and Fenton, R.S., page 49.
55. Allen, E.E., 'On the Comparative Cost of Transit by Steam and Sailing Colliers, and on the Different Methods of Ballasting.' *Proceedings of the Institute of Civil Engineers*, 1854-5: **XIV**; 318-73..
56. Allen, E.E., page 356.

in 18 months during 1854 and 1855[57] it was looking to sell its fleet in 1858.[58] Nevertheless, the steam collier became a permanent feature of the coal trade: around 50 were registered in Newcastle alone in the early 1870s, at least half of which were loading coal on the Tyne for London and the south coast.[59] In 1863, 25 per cent of the coal arriving by sea in London ('sea-coal') was carried by screw collier, and by 1873 almost 100 per cent is said to have arrived this way,[60] although this figure appears too high as the sailing collier was by no means extinct. The average coal cargo delivered to London per ship also grew, being 536 tons in 1875, 709 tons in 1880, 790 tons in 1890 and 1,133 tons in 1900.[61] Although Macrae and Waine have extensively surveyed the fleets of steam colliers which grew up in the latter half of the eighteenth century, their work lacks any analysis as to how exactly the screw collier grew in size and efficiency.[62]

In contrast with the interest in the east coast coal trade, much less has been written about the early use of steam in other bulk trades. Craig refers by name to five steamers carrying bulk cargoes (iron and copper ore and coal) on the west coast in the 1850s, and the prominence he gives to them suggests that steam was relatively important in these trades.[63] However, the present author, who has surveyed steamers owned in ports from Pembroke to Liverpool, found that steamers did not become at all

57. Macrae, J.A. and Waine, C.V., page 15.
58. Craig, R., 'Aspects of tramp shipping and ownership', page 215.
59. Macrae, J.A. and Waine, C.V., page 12.
60. Smith R. *Sea-coal for London: History of the Coal Factors in the London Market*, (London, 1961), page 276.
61. Smith R., page 324.
62. Macrae, J.A. and Waine, C.V.
63. 'By the mid-1850s ore-carrying steamers were a familiar sight in the Irish Sea', writes Craig, but gives only three examples. Craig, R., 'Aspects of tramp shipping and ownership', pages 210-1.

numerous in west coast bulk trades until the 1880s.[64] Part of the research for this thesis will quantify the ships in the trades on the east and west coast.

Apart from Craig's work, the coming of steam to bulk trades other than that involving east coast coal has been glossed over. Waine's work on steam coasters is a worthy one, and he was one of the first authors to call attention to the importance of this breed of ship.[65] But his book does not attempt to look at trades other than from the limited perspective of how individual owners specialised. It is important to estimate when steam began to replace sail in bulk trades other than east coast coal, trades such as coal from Wales, England and Scotland to Ireland, iron ore from Barrow to the Mersey and South Wales, china clay from Cornwall to the Mersey, and limestone from North Wales to the Clyde.

In terms of the evolution of the steam coaster, Waine is simplistic to the point of being disingenuous. His thesis is that steam coasters in general all evolved from early collier designs. However, it is hard to see how, as he states, the 200-foot collier *Tanfield* of 1865 could 'develop' into the 95-foot *St. Seiriol* of 1887 and the 120-foot *Florence* of 1881; the major similarity being the placing of the engines aft.[66] Waine makes no attempt to justify his thesis by following design through a single fleet or through the output of a given yard. It is tempting to suggest that the Clyde 'puffer' - which developed on the Forth and Clyde Canal in the 1850s and rapidly spread

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64. Fenton, R.S., *Cambrian Coasters* (Kendal, 1989); Fenton, R.S., *Mersey Rovers*.
65. Waine, C.V. and Fenton, R.S.. The writer has an interest here: he helped Dr. Waine to revise *Steam Coasters and Short Sea Traders* for its third edition in 1994. His work was largely concentrated on expanding and refining the lengthy chapter on owners and trades, and this involved systematically surveying all the bulk carrier fleets to identify which ships they owned, and when they bought their first and disposed of their last vessel. Waine had essentially three sources for the bulk of his book: spoken testimony of a number of survivors from steam coaster crews, detailed plans of the vessels concerned (the reproduction of these plans is one of the joys of his books), and a relatively few treatises on ship construction.
66. Waine, C.V. and Fenton, R.S., pages 50-53.

outward into sheltered waters on the east and west coast of Scotland – may have contributed to the design of the smaller west coast steam coasters. But this theory is dismissed in an article by Robertson[67], a descendent of one of the pioneer owners of steam bulk carriers in Glasgow, William Robertson, who owned both puffers and early steam coasters in the late 1870s. The development of the steam coaster away from the east coast is a subject which can usefully be pursued. If the west coast bulk carrier was indeed a different animal from its generally-larger east coast cousin, its separate evolution may explain, or be explained by, differences between the trades of the two coasts.

Despite the rapid expansion of the steam bulk-carrying fleet, the coastal sailing ship refused to die. Indeed, competition from steam led to new types being developed, such as the collier sailing barge, built in east coast yards between 1856 and 1891.[68] The total tonnage of ocean and coastal sailing vessels in 1910 was just over one million tons compared with ten and a half million for steam tonnage.[69] On the west coast, sail was particularly resilient, perhaps reflecting fundamental differences in the trades between the coasts. The building of wooden sailing ships persisted on this coast well into the twentieth century; for example, *P.T. Harris* built at Appledore [70]and *Gestiana* at Porthmadog in 1913.[71] Some 85 schooners and ketches are listed as surviving the First World War, many with auxiliary engines.[72] These auxiliary engines

67. Robertson, J.C. and Hagan, H.H., 'A century of coaster design and operation'. *Transactions of the Institution of Engineers* 1954, **XCVII**, 204-256.
68. Finch, R., *Coals from Newcastle* (Lavenham, 1973), page 182.
69. Greenhill, B. (ed.), *The Ship: The Life and Death of the Merchant Sailing Ship* (London, 1980), page 48.
70. Greenhill, B. (ed.), page 48.
71. Hughes, E. and Eames, A., *Porthmadog Ships* (Caernarfon, 1975).
72. Anderson, J., *Coastwise Sail* (London, 1948).

helped ensure the survival of sailing craft into the 1960s[73] by when the steamship itself had been replaced by the diesel-engined coaster in all except a few east and west coast trades.[74] The rise of the steam coaster was therefore not unopposed, and in order to grow to a dominant position it had to overcome problems so successfully that even the surviving sailing ships were driven into ever-smaller niche markets.

The *John Bowes* and its immediate screw collier successors were of very considerable significance in that they established the principles, if not the exact designs, on which steam coasters were based. There were significant numbers of these steam coasters: over 700 in the British fleet in 1927,[75] with many more built in the UK for service throughout the British Empire and elsewhere. But the principles of the early collier – iron hull, screw, water ballast, long unobstructed holds – were applied even more widely in the deep-sea steam tramp which developed from about 1870. No author has been bold enough to describe the *John Bowes* as the progenitor of the ocean-going tramp, but equally none of the works consulted gives the honour to any other vessel.[76] Craig treats the technical developments which the screw collier pioneered as being applicable to vessels large and small in other bulk trades,[77] and undoubtedly the practical shipbuilder and naval architect of the mid-nineteenth century would not see water ballast, unobstructed holds and more efficient engines as

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73. Greenhill, B. (ed.), page 5.
74. Chesterton, D.R. and Fenton, R.S., *Gas and Electricity Colliers* (Kendal, 1984); Fenton, R.S., *Mersey Rovers*.
75. Waine, C.V. and Fenton, R.S., page 11.
76. This applies equally to books which concern themselves entirely with tramps, i.e. Thomas, P.N., *British Ocean Tramps* (two volumes) (Albrighton, 1992) and Course, A.G., *The Deep Sea Tramp* (London, 1960), as well as to more general histories, i.e. Fayle, C.E.; Greenhill, B. 'Steam before the screw'; and Hope, R.. Greenhill's book uses the word tramps on only three occasions and names or illustrates none, despite its claim to be a 'detailed and comprehensive account' of the ship.
77. Craig, R., 'Aspects of tramp shipping and ownership' in Matthews K. and Panting G. (eds.), *Ships and Shipbuilding in the North Atlantic Region* (St. John's, Newfoundland, 1978) pages 209-30; Craig, R., *The Ship: Steam Tramps and Cargo Liners 1850-1950* (London, 1980)

applicable only to the east coast coal trade. Allan's paper on the steam collier, delivered in February 1855, less than three years after the launch of *John Bowes*, has a lengthy discussion on the use of steam colliers to supply distant coaling stations, and this may well be the first time consideration had been given to the use of an ocean-going steam bulk carrier.[78] If the present author's contention that the steam tramp did indeed evolve directly from the screw collier of the 1850s is supported by further research, the *John Bowes* may well be established as one of the most important vessels ever built.

Specialisation in coastal shipping: the liner and bulk trades

The high initial cost of a steamer, and the expenditure on its fuel and additional engine room staff meant that, for the forty years after the maiden voyage of the *Comet* on the Clyde in 1812, steamers were almost exclusively confined to routes where passengers, or high-value, perishable or time-critical freight could attract premium freight rates.[79] The coastal liner trade developed as, to cater for the convenience of passengers and shippers of cargo, sailings began to follow a regular schedule which would be independent of tide and weather, whenever and wherever possible. Jackson suggests the concept of a 'shipping line' developed in the coastal trade during the Napoleonic Wars.[80] The establishment of regular sailing dates, with vessels sailing 'full or not', required a number of ships and back up services, which evolved into a system of ship management.

78. Allen, E.E., 'On the comparative cost of transit by steam and sailing colliers, and on the different methods of ballasting.' *Proceedings of the Institute of Civil Engineers* XIV (1854-5), page 336 et seq.
79. Armstrong lists post, passengers, perishables, and livestock as premium cargoes (Armstrong, J., 'Management response in British coastal shipping companies to railway competition.' *The Northern Mariner* VII (1997), 17-28., page 18), but Palmer suggests steamships were viable only in the passenger and livestock trades (Palmer, S., page 234).

The advent of the screw collier in the 1850s introduced steam to a new type of trade, bulk carrying, which had hitherto been the province of the sailing vessel. Innovations introduced with the screw collier - water ballast tanks, large uninterrupted holds and hatches, and gradually improving engine efficiency - were available for ships built for the coastal liner trade. Ships built for the bulk trade were not infrequently chartered or even sold to companies operating liner services and obsolete coastal liners were sometimes bought for use as bulk carriers. However, despite these occasional crossovers the two trades remained quite distinct. It is notable from the surveys of owners and their trades in works on steam coasters (essentially, bulk carriers), steam colliers and coastal liners[81], and from detailed work on individual west coast owners,[82] that the great majority of owners rigorously specialised either in bulk carrying or liner trade operations. This section examines the differences between these and offers definitions of the two trades.

A liner service has been defined by Fayle as '...a fleet of ships, under common ownership or management, which provide a fixed service, at regular intervals, between named ports, and offer themselves as common carriers of any goods or passengers requiring shipment between those ports and ready for transit by their sailing dates.'[83] No parallel definition of bulk trades has been found. In arriving at a definition, characteristics to be considered include the commodities carried, the routes and

80. Jackson, G., 'Operational Problems of the Transfer to Steam. In: Smout, T.C. ed., *Scotland and the Sea* (Edinburgh, 1992)
81. Steam coasters in Waine, C.V. and Fenton, R.S.; the specialised coastal colliers in Macrae, J.A. and Waine, C.V.; and the liner trade vessels in Waine, C.V., *Coastal and Short Sea Liners*.
82. Fenton, R.S., *Cambrian Coasters*; Fenton, R.S., *Mersey Rovers*.
83. Fayle, C.E., page 253.

regularity of sailings, the types of vessels involved, and the shoreside organisation required by the trade.

The major characteristic common to all bulk trades is that only one type of commodity is carried on a given voyage. Normally, for at least one leg of the voyage, this commodity is loaded to the carrying capacity of the vessel, either in terms of weight or of stowage space above or below decks. Smaller loads may be accepted if that is all that is available, or where there are constraints on loading or discharge, such as draft restrictions. This is in contrast to the vessel in the liner trade which will typically carry a number of packets of different commodities, in varying amounts. These commodities are not necessarily loaded to the vessel's capacity because maintaining a schedule is usually judged more important than maximising the cargo carried on a particular voyage. The liner trader sees the opportunity for maximum profit as providing a reliable service to shippers on a long-term basis.

Although any shipowner relishes the opportunity to carry a cargo in both directions, and so avoid an unpaying voyage, opportunities to do this are generally greater in the liner trade, where packets of more than one commodity are the rule. In many bulk trades, the chances of finding return cargoes were small. The vessels of William Savage's Zillah Shipping and Carrying Co. Ltd. found their main employment carrying coal from the Mersey to Ireland,[84] but - like other Irish Sea traders - could rarely count on return cargoes, agricultural produce - the major Irish export - usually being brought to Liverpool by coastal liner. Savage's solution - a partial one - was to sail eastwards in ballast and load stone for the Mersey at one of the North Wales

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84. Fenton, R.S., *Mersey Rovers* page 265 et seq.

quarry jetties. Thus a 'triangular' trade developed which could minimise but not eliminate ballast passages for the bulk carrier. In a review of the trade at a small north west port, Connah's Quay, Armstrong and Fowler list one of this port's weaknesses as an imbalance between inward and outward cargoes.[85] They suggest that owners of ships would prefer to use a port which gave them the opportunity of two freight-earning voyages. Whether the ready availability of a return cargo was a bonus is debatable, however. It would inevitably have forced down freight rates, as shipowners would be more willing to quote a lower rate for taking a cargo into a port if they were assured of taking an earning cargo out. Armstrong and Bagwell point out that the capacity of colliers returning northwards from the south of England to Newcastle was so great that return freight rates were very low.[86] Steam colliers in the trade from north east coast ports to London almost invariably made the northbound passage in ballast.[87] A rapid turnround so that they could be back at the coal loading port as quickly as possible was preferred by the collier owners to the time and expense involved in waiting and preparing for a northbound cargo, such as cement from the Medway to the Tees. Such cargo was left to other owners, such as Liverpool's W.S. Kennaugh and Co.[88] Armstrong and Fowler themselves quote examples of regular traders into Connah's Quay who disdained a back cargo, probably because its loading would have unduly delayed their return voyage.

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85. Armstrong, J., and Fowler, D., 'The coastal trade of Connah's Quay in the early twentieth century: a preliminary investigation.' *Flintshire Historical Society Journal*, 1996; **34**: 113-33
86. Armstrong, J. and Bagwell P.S., page 169.
87. See for instance, Armstrong, J., 'Late nineteenth century freight rates revisited: some evidence from the British coastal coal trade.' *International Journal of Maritime History* 1994; **VI**: 45-81; Chesterton, D.R. and Fenton R.S.; Macrae, J.A. and Waine, C.V.; Keys, D. and Smith, K., *Black Diamonds by Sea: North East Sailing Colliers 1780-1880*, Newcastle-on-Tyne, 1998.
88. Fenton, R.S., *W.S. Kennaugh & Co. and the West Coast Shipping Co. Ltd.* (Kendal, 1979).

The common carrier status of liner trade operators gives them little discretion in what cargo is carried although, as Armstrong points out, dangerous or unpleasant cargoes such as explosives, coal or hides may be shunned by operators whose vessels cater also for passengers.[89] In the bulk trades, in contrast, the operator will exercise complete discretion as to what cargoes his ship loads, what ports it visits, and the freight rates accepted, all with a view to maximising short-term earnings. This freedom may be limited by a long-term agreement such as a charter, but again the operator uses his discretion in making such an agreement.

Commodities carried in the coastal bulk trades fall into three broad categories:[90]

1. Raw materials, referred to in railway parlance as minerals: coal, limestone, chalk, building stone, sand, iron, lead and copper ores, china clay, salt, and basic slag.

2. Products of agriculture and forestry: cereals, hay, manure, timber, potatoes, cotton and wool.

3. Bulky manufactured products: in the period covered by this thesis (1850-1914) those which have been carried in bulk included railway rails, pig iron, tinplate, bricks, slate, tiles, dressed stone, lime, flour, cement, artificial fertilisers, chemicals, petroleum products, and barrels. Many commodities in this category cannot be dismissed as low value, and some were also carried, usually in smaller packets, in liner trade vessels.

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89. Armstrong, J., Cutler, J. and Mustoe, G., pages 41-63.

90. This list of commodities has been compiled from listings of cargoes carried by bulk-carrying steamers in works such as Coppack, T. *A Lifetime with Ships*, (Prescot, 1973); Fenton, R.S., *Mersey Rovers*; Fenton, R.S., *Cambrian Coasters*; and Waine, C.V. and Fenton, R.S. The completeness of the list is confirmed by a work considering the post-Second World War period: Ford, P. and Bound, J.A., *Coastwise Shipping and the Small Ports* (Oxford, 1951). Reports of casualties routinely list the cargoes carried, and a few isolated examples of cargo books for individual vessels have survived, often in private hands.

Commodities in categories 1 and 2 share the characteristic of being carried unwrapped. Characterised by relatively low-value and lack of urgency, these categories comprised the most frequent cargoes of bulk-carrying vessels.

The liner traders run their vessels on a fixed route and this will not vary greatly from year to year, although they may switch vessels from one regular routes to another. The route may involve calls at a number of intermediate ports, although some may be visited only if the shipper provides sufficient inducement. The operators in the bulk trades seek to employ their vessels between whatever ports will maximise earnings, although again this freedom may be constrained in the short term by a charter or other commitment. Calls at intermediate ports to load or discharge part of a bulk cargo are unusual.

Liner vessels almost invariably run to an advertised schedule, and where conditions permit this frequently disregards tides and weather. The owner of a bulk carrier will seek to make as many voyages as possible, but the sailing times and dates are not fixed, and depend on the needs of the shipper, who may or may not have a cargo available and facilities to load it, and the requirements of the consignee who may need to arrange to unload, store or move the cargo. In general, bulk cargoes are of relatively low value and until the current preoccupation with 'just in time' delivery, it was usually permissible (and often essential in ports with limited depth of water) to allow sailing times to be determined by tide and weather.

Freight rates in the liner trade were advertised, fluctuating only if there were exceptional circumstances, such as new competition or shortage of vessels due, for instance, to a war. However, to maintain and attract custom, operators frequently give discounts to regular shippers. In the bulk trades, freight rates are subject to negotiation between the ship operator and the shipper (or their agents) and often vary considerably in accordance with the supply of suitable and well-placed ships, and the urgency of delivering the cargo.

Craig, referring to deep-sea trades, has pointed out that tramp shipping can be a hazardous business, critically affected by cyclical fluctuations, by the hazards of war, by crop failures and gluts.[91] Unlike the liner trade, where conferences and the protective umbrellas of other agreements achieved some stability in the matter of freight rates, attempts by tramp operators to form associations to fix rates in times of adversity invariably failed. But, despite the exceptional risks attached to tramp shipping, there were always plenty of newcomers, suggesting that in spite of the hazards the rewards could compensate the steadfast operator. When freight rates were high, the potential profits were extremely attractive, often appearing to exceed those from other forms of investment. In contrast, the coastal liner operator, although spared the depths of depression, could not take full advantage of any rise in freight rates. Whilst doubting that a meaningful comparison of the profitability of liner and tramp companies could be conducted, Craig has the impression that the tramp owner did better, at least before 1914, and in support cites the extraordinary financial success of many tramp ship owners.

From 1850, steam vessels evolved to the extent that there were significant design differences between vessels intended for the liner and bulk trades,[92] although rarely were the differences so extreme that the vessels could not be interchanged. The

91. This paragraph is based on Craig, R., 'Aspects of tramp shipping and ownership', page 224.

liner usually had at least one extra deck (a 'tween deck) worked into its structure to facilitate carrying small packets of goods, some of which would require special precautions in handling or stowage. The bulk carrier had one or more holds which used almost the full depth of the hull in order to maximise carrying capacity. Cargo gear - derricks or cranes, and winches - was generously provided in liner trade vessels in order to expedite loading and discharge. Some liners had doors in the side of the hull for livestock. The bulk carrier had the minimum of gear, usually only for use when shoreside gear was unavailable, and in the case of many vessels dedicated to set routes had none, relying entirely on shoreside gear. In liner traders, engines were sometimes more powerful than those specified for bulk carriers to help maintain schedules, or - in the case of ships with passenger capacity - to shorten journey times. Some, but by no means all, liner vessels had passenger facilities, and in the bigger and faster cross-channel ships this was more important than cargo capacity. Bulk carriers almost invariably had water ballast capacity (ballast tanks and/or double bottoms) as it was expected that one leg of a round voyage would be made in ballast. In contrast, water ballast facilities were reduced or absent in liners, as it was anticipated that enough cargo would be carried even on the least busy leg of a voyage to maintain stability and keep the screw immersed.

Liner traders needed more extensive and sophisticated shoreside organisations than operators in bulk trades.[93] Packets of cargo and passengers had to be booked, invoiced, stored, and their loading or discharge organised, usually necessitating an office or at least an agent and probably a warehouse at each port served. Port and

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92. This paragraph is based mainly on general descriptions of the two types of vessel in Waine, C.V. and Fenton,

harbour authorities often dedicated berths to liner traders, and facilities for storage and cargo handling were constructed. In contrast, the bulk trader would usually have nothing but a minimal office staff, contracting any business in ports served to local agents and brokers.

Consideration of the above characteristics of the liner and bulk trades, which are summarised in table 2.2, leads to the following definition of a bulk trade. 'A bulk trade involves carrying one type of commodity on each voyage, with the schedule of the sailings, the freight rates, and the choice of loading and discharge ports all being subject to agreement only by the shipper, consignee and the ship's operator (or their agents), with the operator exercising discretion on what cargoes are accepted.'

Armstrong has distinguished two types of powered coastal bulk carrier.[94] One type, of which the east coast screw collier was the most prominent example, was dedicated to a limited range of routes and commodities, frequently returning to its loading port in ballast. The other type he describes as the steam tramp, carrying consignments which filled a ship but required movement less frequently and regularly.

R.S., and Waine, C.V., *Coastal and Short Sea Liners*.
93. Fayle, C.E., chapter 10.
94. Armstrong, J., 'The crewing of British coastal colliers: 1870-1914' *The Great Circle* 20 (2) (1998), 73-89.

Table 2.2: Comparison of the characteristics of the bulk and liner trades

Feature	**Liner trade**	**Bulk trade**
Number and amounts of individual commodities carried.	Highly flexible. Operator has little discretion as to what is carried.	One type of cargo per voyage, usually loaded to vessel's capacity. Operator exercises discretion as to what is carried.
Type of commodities predominantly carried.	Manufactured goods and foodstuffs, including livestock.	Raw materials or those manufactured items which can be shipped in large quantities.
Routes	Fixed, often with calls at a number of ports on a set route.	Highly flexible. Any one voyage will usually involve only two ports.
Scheduling	Regular and timetabled.	Determined by availability of cargo, demands of shipper and consignee, and facilities at port used.
Return cargoes	Regularly carried.	Exceptional.
Freight rates	Published and set, although discounts regularly given. Limited fluctuation over the trade cycle.	Subject to agreement by shipper and owner. Subject to considerable fluctuation.
Design of vessels	Intermediate decks . Enhanced cargo gear. Often more powerful engines. A number had passenger capacity. Water ballast capacity not always necessary.	One or more holds to full depth of hull. Minimum of cargo gear. Smallest engines to maintain 9-10 knots. No passenger capacity. Water ballast capacity.
Shoreside organisation and facilities	Head office plus office or an agent permanently employed in each port regularly served. Dedicated berths with passenger and cargo storage and handling facilities.	Cargoes fixed by head office or by shipbrokers. Agents appointed on an as-needed basis. Berthed wherever shoreside loading/unloading gear available.

The ocean-going version of the tramp steamer is well described, at least in popular literature, although authors tend to completely ignore the coastal variety.[95] Although failing to consider coastal trades, Fayle gives one of the most succinct accounts of how the ocean-going tramp trades evolved.[96] He describes how, in the latter half of the nineteenth century, steam-driven passenger and cargo liners had been developed to work regular routes, but how this left much trade which was not of a regular character. This included products, such as cereals and cotton, with whose seasonality regular liners could not cope, ports whose trades were too small to induce a regular service to call but occasionally produced a paying cargo, and what he describes as 'rough' bulk cargoes, such as iron ore, coal and timber, usually bought and shipped in consignments large enough to fill a vessel, and which could not be carried conveniently as part of a liner cargo. Sailing vessels took much of this cargo, but from about 1880 they had a formidable rival in the tramp steamer. The invention of the submarine cable was essential to the steam tramp trade, as it allowed tramp owners to direct their vessels to ports where cargoes were available.

So little has been written about coastal tramping that it is not clear how and when it became a clearly-differentiated trade. In his first book on coastal ships, Waine lumps steam coasters (in which group he includes all ships and owners who were in the coastal tramp trades) and steam colliers together, and identifies them as having a common origin in the screw colliers of the 1850s.[97] However, although he perceives common features such as water ballast tanks, he does not convincingly chart how the

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95. For instance, see Course, A.G., *The Deep Sea Tramp* (London, 1960). Thomas attempts a much deeper consideration in his two-volume work Thomas, P.N., *British Ocean Tramps* (Albrighton, 1992).
96. Fayle, C.E., chapter 10.
97. Waine, C.V. and Fenton, R.S., chapter 4.

steam coaster/tramp, which was on average significantly smaller than even the earliest colliers, developed. One objective of the current research is to investigate whether the steam coaster which became ubiquitous in west coast trades towards the end of the nineteenth century evolved from the collier.

The distinction Armstrong makes between collier and tramp types can become blurred. Companies trading on the Irish Sea, such as the Zillah Shipping and Carrying Co. Ltd. of Liverpool[98] and Joseph Fisher and Sons of Newry[99] predominantly carried coal to Ireland, but their ships served a variety of ports, and would frequently load non-coal cargoes including stone, china clay, grain, or fresh fruit and potatoes when these offered. Indeed, it is unwise to regard even the coastal steam tramp owner as being completely unfettered as to employment of their ships. The specialisation of the Zillah company has just been referred to, whilst a contemporary owner in the same port, Richard Hughes, specialised in carrying china clay from the south west to the Mersey and Preston.[100] It is probably more useful to do as Waine did, and regard the ships and owners specialising in the bulk trades as occupying a continuum. At one extreme, there was complete absorption in carrying one type of cargo on one or more related and unvarying routes, as exemplified by collier owners like the gas and electricity companies,[101] and independent coal merchants such as William Cory,[102] Stephenson Clarke,[103] and France, Fenwick.[104] At the other extreme of the continuum there were owners who acted with seemingly-complete freedom to trade wherever the

98. Fenton, R.S., *Mersey Rovers*, page 265.
99. Fenton, R.S. and Patterson, S., 'Fishers of Newry' in Fenton R.S. and Clarkson, J. eds. *British Shipping Fleets* (Preston, 2000).
100. Fenton, R.S., *Mersey Rovers*, page 84.
101. Chesterton, D.R. and Fenton R.S.
102. Keenan, K.E., *The Fires of London* (Waldron, East Sussex, 1997).
103. Carter, C.J.M., *Stephenson Clarke* (Kendal, 1981).

best living could be made at a given time, the classic coastal tramp operations exemplified by W.S. Kennaugh and Co. of Liverpool, whose ships ranged right round the UK coast.[105]

From the differences in the two trades in table 2, it is possible to explain why coastal shipowners almost invariably confined their activities to either the liner trade or the bulk trade, and in the case of the latter specialised even further by operating in one trade such as that carrying east coast coal.

The design of the ideal ship for the two trades was often different. A bulk carrier with one or more full-depth holds was not best suited to carrying packets of goods, whilst a 'tween deck would be a positive encumbrance when carrying coal. The bulk carrier invariably lacked passenger capacity, which was necessary in certain regular trades.

The shoreside organisation demanded by the two types of trade was very different. The liner company or their agents required clerks to issue tickets and check in consignments of cargo at each and every port served. They often had to lease or purchase an office or shed where these operations could be carried out, and a warehouse or other facilities for the temporary storage of cargo. The staff had to be managed and paid, and the fares and freights counted and banked. In contrast, the company specialising in bulk carrying would have the very minimum of office staff, just sufficient to supervise the ships and their crews, and to fix cargoes, although even the latter might be contracted to a shipbroker.

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104. Anonymous, *Wm. France, Fenwick and Company Limited* (Privately published, London, 1954).

The relative importance of the coastal trade sectors

Estimates made by Armstrong and fellow workers of the total work done by coastal shipping,[106] and of the work done by coastal liners [107] allows comparisons to be made of the importance of the various sectors of the coastal trade.

To estimate the work done by coastal liners in 1914, the *Directory of Shipowners, Shipbuilders and Marine Engineers* was used to identify steamers owned by liner trade companies and find their routes. From daily shipping newspapers and crew agreements were found the actual number of voyages these vessels made during the month of July 1914. The vessels' deadweight capacity was multiplied by the distance run to give the total work done in a year. The estimate of the total work done annually by coastal liners was 6,264,791,600 ton-miles, and the average haul was 312 statute miles. The authors identified fifty individual companies operating a total of 138 routes serving 77 ports. The most important ports were Liverpool, London, Glasgow, and Dublin; and the most important routes were Dublin to Liverpool and London to the north west.

A number of reservations need to be expressed over the methods used in the above study. The calculation of work done assumed that the quantity of cargo carried by a vessel was the same as its carrying capacity. This is an unsafe assumption as it is unlikely that, even if a vessel was fully laden in one direction or on one leg of a voyage (which, in the liner trade, frequently involved a 'stopping' service between

105. Fenton, R.S., *W.S. Kennaugh & Co. and the West Coast Shipping Co. Ltd.*
106 Armstrong, J. 'The role of coastal shipping in UK transport: an estimate of comparative traffic movements in 1910'.
107. Armstrong, J., Cutler, J. and Mustoe, G.

multiple ports), it would load to the same capacity for the return voyage.[108] This factor may result in an overestimate of the work done by liner trade vessels.

A lesser source of error, and one which may tilt the results towards underestimating the work done by the liner trade, is the reliance placed on the *Directory of Shipowners, Shipbuilders and Marine Engineers* to list all the companies and vessels engaged in the coastal liner trades and their routes. As a reliable and comprehensive source, the *Directory* does not enjoy the same reputation as *Lloyd's Register* nor the *Mercantile Navy List*, although neither of these annual publications describes a company's trade. There is evidence that some companies which were engaged primarily in coastal tramping also operated regular services from time to time,[109] and these companies are unlikely to be listed in the *Directory* as operators of liner services. A potentially bigger source of error is that liner companies chartered vessels from tramp companies when trade exceeded the capacity of their own fleet,[110] and such vessels would not be listed in the *Directory* as part of the liner company's fleet.

Comparing the estimated figure of 6.3 billion ton-miles for coastal liners in 1914 with an earlier estimate of 20.4 billion ton miles for the whole of the coastal trade in 1910[111] leads to some interesting conclusions. Of the 1910 total, coal and

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108. An example of such an imbalance is given by Somner for the Carron Company's London to Grangemouth sailings. In 1894, when the company was probably at the height of its power as a coastal carrier, 54,472 tons of cargo was carried from Grangemouth to London, whilst only 29,734 tons were carried northbound. Somner, G., 'The Carron Company' in Fenton R.S. and Clarkson, J. eds. *British Shipping Fleets*, (Preston, 2000), page 167.
109. Several examples of tramp owners operating liner services are given in Fenton, R.S., *Mersey Rovers* (Gravesend, 1997) and in chapter 12 of Waine, C.V. and Fenton, R.S. Of these companies, one of the most notable was S.W. Coe and Co. Ltd. of Liverpool who combined tramping with a general cargo service between Liverpool and Coleraine.
110. Captain Owen Spargo relates how over a long period Cunard chartered coasters from companies in the bulk trade to run between Liverpool, the Channel Islands, and Le Havre. Spargo, O.G. and Thomason, T.H., page 81.
111. Armstrong, J. 'The role of coastal shipping in UK transport: an estimate of comparative traffic movements in 1910'.

coke accounted for 7.2 billion ton-miles, or about 35 per cent. The quantity of coal and coke carried is the best supported of the figures used, being based on the actual tonnages of coal carried coastwise from each UK port, figures which were quoted in parliamentary papers. On the assumption that trade in 1914 was not greatly different from that in 1910, the figures for 1914 suggest that the coastal liner trade could be expected to account for some 31 per cent of coastal traffic. The remainder, some 34 per cent, must therefore be accounted for by non-coal traffic carried in vessels other than coastal liners. Is this figure credible? Sailing ships are unlikely to have made a significant contribution: in 1900 they accounted for only one eighth of the tonnage entered coastwise in UK ports, and ten years later this figure would have dwindled to even less.[112] The only other published survey of carrying capacity in the coastal trade is based on traffic in 1948.[113] About 8.8. billion ton-miles were worked in 1948, of which coal voyages accounted for 7.6 billion ton-miles, or 86 per cent. The coal traffic in 1948 was much the same as in 1910 and, even if the coastal liner trade over the intervening years had collapsed completely,[114] it must be questioned whether 'non-coal, non-liner' traffic - which must comprise materials such as stone, grain, and bricks - could have declined from 6.9 billion ton miles to 1.2 ton billion miles.

Problems to be solved by coastal steam ship operators

This section considers the obstacles that had to be overcome before coastal steam shipping, especially that concerned with the bulk trades, could achieve the important

112. Armstrong J. 'Climax and climacteric: the British coastal trade, 1870-1930', page 42.
113. Ford, P. and Bound, J.A.
114. Several authors including Aldcroft and Pollard attest to a decline, but not to a complete collapse. A significant factor in all coastal trades is the removal of trade with Southern Ireland from the figures in 1923. Aldcroft, D.H.; and Pollard, S. and Robertson, P., *The British shipbuilding industry, 1870-1914* (Cambridge, Mass., 1979)

position it did in 1914. Considering the response to these problems by steam ship operators will help to understand how the transition from sail to steam came about.

Port facilities and practices had important influences on the adoption of steam in a given bulk trade. To overcome its disadvantages of high capital and running costs, the steam bulk carrier had to make more passages in a given time than competing sailing craft, and so had to load and discharge as quickly as possible. Thus ports wishing to encourage steamers had to develop facilities to handle bulk cargoes more rapidly, and there had to be a change in any practice that meant a ship took its turn to load or discharge strictly in the order in which it entered the port, a system which was anathema to the screw bulk carrier.

The development of coal loading facilities cannot be separated from the story of the development of the steam collier, and in their history of the collier fleets Macrae and Waine do cover the loading staithes at coal ports, if a little unevenly.[115] For instance, dates are given for the London and North Western Railway's developments at Garston which influenced the port's capabilities in coal exporting. But for the development of the high-level coal railway at Bramley Moore Dock, Liverpool – which was the Lancashire and Yorkshire railway's response to developments at Garston – reference must be made to more local histories.[116] One must search elsewhere for more than a passing mention of the facilities developed by the Great Western Railway at Birkenhead.

The provision of mechanised unloading facilities on the Thames has also been well recorded, especially the floating platforms *Atlas No. 1, Atlas No. 2* and *Atlas No.*

115. Macrae, J.A. and Waine, C.V., page 22 et seq.

3 which were built for William Cory from 1860.[117] Nevertheless, the construction of such facilities invariably lagged behind the growth in trade, and Craig has pointed out that there was greater progress in effecting the rapid loading of coal than in the technically more complex business of discharging bulk cargoes.[118] Such advanced facilities favoured the steam collier with its much larger hatches over the sailing collier, whilst the rigging of a sailing ship would also hinder attempts to mechanise loading and discharging.

Several authors refer to the need to abandon the turn system of loading and discharge following the arrival of the screw collier. Craig says that '…soon after the advent of the commercially successful steamship it became the custom at most coal-loading ports for steam vessels to be given priority over sailing vessels, presumably in recognition of the greater capital embarked in the former, and no doubt a shrewd calculation by dock and harbour authorities that revenue would be increased by showing favour to steamships capable of rapid repeated voyages.'[119] According to Keys and Smith, the *John Bowes* herself was the subject of an action brought by a sailing ship owner. After loading Tyne coal for Grimsby in 1853, her place under the coal spouts was taken by the sailing collier *William.*[120] When only part of the *William's* coal cargo had been loaded, the *John Bowes* returned, and the sailing ship was hauled off to make way for her. The *Williams'* owners brought a successful action under the Coal Turn Act against the coal fitter, and it is suggested that this led

116. Jarvis, A., *Liverpool Central Docks 1799-1905: an Illustrated History* (Stroud, 1991).
117. Macrae, J.A. and Waine, C.V., page 47 et seq.; Keenan. K.E., pages 7-8.
118. Craig, R., 'Aspects of tramp shipping and ownership', page 222.
119. Craig, R., 'Aspects of tramp shipping and ownership', page 214.
120. Keys, D. and Smith. K., page 43. The 'Coal Turn Act' referred to here is presumably the Coal Trade Act, 1730 (4 Geo.2) CAP. XXX which, as discussed in chapter six, applied only to the River Thames. It is likely that

to the steamship owners building a staithe reserved entirely for steamers. It needs to be established whether there were such restrictive practices or legislation which affected how steamers penetrated bulk trades to and from other ports. As the case of the steamer-only staithes on the Tyne suggests, the ownership and management of ports also affected how they handle coastal bulk shipments.

Finance was a major problem for the would-be steamship owner because of the high capital costs involved in the construction of a wooden or iron hull sufficiently strong to withstand the stresses imposed by the engine, and the high cost of the boilers and engine.[121] In the late 1820s, a modest 100-ton, 50 horsepower steam packet cost around £5,800, and 25 years later a 1,000 ton vessel would cost around £45,000. The effect of this was to put the ownership of a steam vessel beyond the financial resources of an individual or small partnership.

There were four financial avenues open to would-be steamship owners, ocean or coastal.[122] The time-honoured method was ownership on the 64th share system. A royal charter to set up an unincorporated company cost around £400 and could be opposed: competing companies had a right to object to the application. Examples of coastal companies obtaining charters included the General Steam Navigation Company (1847) and the St. George Steam Packet Company. Ownership by a limited liability joint stock company became possible after the Joint Stock Companies Act of

in other ports bye-laws regulated loading in a similar way, and that the Grimsby action was under such a local regulation.

121. Palmer, S., page 234.

122. Cottrell, P.L., 'The Steamship on the Mersey, 1815-80: Investment and Ownership.' In: Cottrell, P.L. and Aldcroft, D.H. eds. *Shipping, Trade and Commerce: Essays in memory of Ralph Davis*. (Leicester, 1981). Also other references cited therein.

1844, and it was made progressively simpler and more straightforward by legislation introduced between 1856 and 1862.[123]

No published work has been found which looks systematically at the ownership pattern of ships in the coastal bulk trades. Ownership details in *Lloyd's Register* and the *Mercantile Navy List* make it possible to decide whether a ship was owned by individuals, an unregistered company, a registered company like Lambton Collieries Ltd. or William Cory and Son Ltd., or a single-ship company like the Agnes and Louisa Shares Co. Ltd. Trends in ownership over time will suggest how steamship owners overcame problems of obtaining finance, and whether they took advantage of changes in the law that made it easier to raise capital.

Having significantly greater costs than the sailing ship, the steamship brought a need for better - or at least more intensive - management, in order to maximise its employment and profit. One result was the rise of the ship manager, or management company, who raised the capital for the ship and then supervised its employment. Did this require a more sophisticated shore-based operation than the sailing ship, and one which required new skills?

A further disincentive to invest in steam was the greater vulnerability of steamships to downturns in the trade cycle, especially in the bulk trades.[124] Craig has pointed to the tramp trade under steam as being 'critically affected by violent cyclical fluctuations'.[125] A slump favoured sailing ships, whose lower operating costs allowed them to wait for cargoes rather than go into lay-up. Thus, the depression of 1874 to

123. Armstrong, J. and Jones, S., *Business documents: their origins, sources and uses in historical research.* (London, 1987)
124. Cottrell, P.L., page 144.
125. Craig, R., 'Aspects of tramp shipping and ownership', page 221.

1879 caused a fall in the value of steamers and the shares of companies which owned them. Conversely, an upturn in trade saw new orders being placed, and at the end of the 1870s these were predominantly for steamers. Craig points to the difficulty of perfecting an economical steamship which could trade profitably when times were good, and could earn at least enough to cover its depreciation in times of depression.

Operators faced opposition from other shipping companies. Given the high capitalisation of a steamship, the cost of failure was ruinous, and - on regular routes where there were two operators but trade enough only for one - fierce rivalry resulted, with fares and rates cut, and companies looking to the speed, appearance and apparent luxury of their vessels to attract custom.[126] These factors may have led steamship owners to economise on construction, and probably as a result repair costs were disastrous for many concerns.

The study of competition has considered only the liner trades, and it remains to be asked how the tramp owners address the question of rival operators. For instance, was the owners' response to competition the spate of mergers which affected the steam collier fleets from the 1890s, which led to the formation of France, Fenwick[127] and to the enlargement of the William Cory empire?[128]

The technical problem facing the operator of the steamship is simply stated: reducing building and operating costs to such a level that the steamer can successfully compete with sail in a chosen trade, even in times of depressed freight rates. Achieving this was, of course, an immensely complex and long-drawn out process,

126. Palmer, S., page 235.
127. Anonymous, *Wm. France, Fenwick and Company Limited* (London, 1954)
128. Anonymous, *One Hundred Years of the Cory Fleet* (Kendal, circa 1961)

with a mass of relatively minor advances in technology contributing to improving the overall efficiency and economy of the hull and machinery of the steamer.

The development of marine steam engines as applied to coastal ships has, perhaps, been better documented than the ships themselves. Most accounts rehearse the familiar progression, with an almost seamless series of technological developments leading to ever more efficient steamships.[129] However, a critical look at the minutes of pioneering steam ship companies suggests that the high costs involved in buying and operating steamships meant that owners were not readily disposed to experiment with untried technological innovations.[130] The owners' desire for greater speed as a means of beating off competition on their routes was thus usually met by modifying existing technology rather than by embracing the new. Obsolete technology persisting included the side-lever engine, still the most popular type of machinery in the 1850s although essentially unchanged since it had been developed by James Watt. Early paddle steamers relied on technology developed for beam engines for use on land, and there was a case of one such engine being used in a screw steamer as late as 1859, the *Thistle*.[131]

Despite aberrations such as the *Thistle*, a number of other types of engine were developed to give the higher speeds required for screw propulsion: horizontal, vee, vertical and inverted.[132] .Vee engines, with two cylinders in a V driving a single crank, were used in early colliers as they took up little space in the after end of a

129. See for instance, Waine, C.V., *Coastal and Short Sea Liners*; and Rowland, K.T.
130. Palmer, S., pages 209-30.
131. Waine, C.V., *Coastal and Short Sea Liners*, page 28.
132. Waine, C.V., *Coastal and Short Sea Liners*, page 28 cites these without developing the subject.

hull.[133] However, the inverted engine, introduced in the 1860s, eventually became the most widely used of the steam reciprocating engines in coastal ships.[134]

The growing dominance of steam in the ocean trades from the 1870s resulted from improvements in technology,[135] especially much higher boiler pressures and - a necessary parallel development - compounding to use efficiently the high pressure steam by expanding it in two cylinders. The logical progression of compounding was the triple-expansion engine, introduced in the 1880s, typically with three cylinders: high, intermediate and low pressure. A further development, quadruple expansion, gave slightly greater economy in return for increased cost, complexity, weight and length, disadvantages which meant that in the coastal trade it was adopted only for passenger ships where speed was important, for instance the *Graphic* built in 1906 for the Liverpool to Belfast service.[136] Even in this limited type of application it was soon made obsolete by the development of the turbine. In parallel with more efficient use of the steam were improvements in boiler technology which increased the efficiency with which fuel was turned into propulsive power, and improvement in condensers.[137]

Internal combustion engines appeared in coastal ships right at the end of the period under review, with the *Lochinvar* of 1909 for the regular sailings between Oban and Tobermory,[138] and for the bulk trades a group of very small motor coasters built along the lines of Clyde 'puffers' from 1912.[139] Their small numbers meant that, before 1914, vessels with internal combustion machinery made little impact in the

133. Macrae, J.A. and Waine, C.V., page 13.
134. Waine, C.V., *Coastal and Short Sea Liners*, page 28 is not entirely convincing on the reasons for this development.
135. Cottrell, P.L., page 142.
136. Waine, C.V., *Coastal and Short Sea Liners*, page 28.
137. Bruce, J.G., page 72.
138. Waine, C.V., *Coastal and Short Sea Liners*, page 30.

coastal trade. Just two types of engine, compound and triple expansion, powered the great majority of coastal ships, including cargo and cargo-passengers liners and bulk-carriers.[140]

Advances in steam technology have been well documented, but although they inform us about how the steamship became more efficient, they do not quantify this improvement. It would be instructive to chart the changing efficiency of the machinery of the typical bulk carrying steamers from 1850 to 1914, as this would reflect its ability to penetrate trades. A related question concerns advances in techniques for building hulls, machinery and boilers: did the industrialisation of shipbuilding and of iron and steel production reduce the construction costs of steamers and make them more competitive with sail? Not all technological developments favoured steam over sail. The developments in production of mild steel, for instance, could benefit those building sailing ship hulls as much as it did the builders of steamships.

Railways provided the first serious competition which coastal shipping faced. Between the first voyage of the *Comet* in 1812 and the opening of the first public railways in the 1820s, steamship operators built up a considerable network of short-sea and coastal services, despite the limitations of existing marine engineering technology and the relatively high costs of steam vessels.[141] The earliest railways were not seen as a threat to coastal shipping, but rather as feeders to the coastal shipping network. The early colliery lines in Durham and Northumberland were built to move coal from

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139. Fenton, R.S., 'The Innis boats: a reappraisal' *Ships in Focus Record*, **26**, 86-99
140. Waine, C.V. and Fenton, R.S. chapter 3 is devoted to the engine room of the steam coaster, describing with diagrams the operation of these engines, their boilers and ancilliary machinery.

pithead to the nearest navigable water, where coastal colliers could ship it south. The Stockton and Darlington had essentially a similar function, and led to massive expansion in coal shipments from the port of Middlesbrough. It was only in the 1840s that a national rail network took shape, and with it the potential for railways to compete with coastal shipping in the business in which the latter excelled, the long-distance movement of freight, a potential which was realised in the 1850s. Coastal shipping management sought to minimise this competition by extending their pools and conferences - semi-secret cartels which fixed rates and shared out the available cargoes - from involving just steamboat owners to encompassing rail companies as well. They were able to do this because coastal shipping could usually offer a price advantage, which accrued from its lower fixed costs, in not having to finance and maintain permanent way and other facilities.[142] A spectacular example of how coastal shipping could compete with railways was the Wilson Line service between Hull and Liverpool, over 1,000 miles by sea compared with rail links of around 120 miles.[143] Even where no collusion between rail and coastal shipping was apparent, ship operators fixed their rates according to the class of commodity carried in exactly the same way as did the railways, usually setting the rates to undercut rail. Thus, by classifying commodities in the same way, the coastal operators made their price advantages transparent to potential customers.

It is less clear whether coastal ship operators gained an advantage through technological improvements, as locomotive technology was also advancing. The only

141. The following three paragraphs are based on Armstrong, J., 'Management response in British coastal shipping companies to railway competition.'
142. Armstrong, J., 'Coastal shipping: the neglected sector of nineteenth-century British transport history', page 187.

documented area where such changes allowed coastal shipping to fight off railway competition was in the east coast coal trade, where advances such as screw propulsion, water ballast and larger and more economical steam colliers eventually re-established the dominance of coastal shipping.

An obvious management response to competition was the amalgamation of coastal shipowners, which affected collier companies in the 1890s, and liner companies throughout their existence, with notable mergers towards the end of the period under review, such as that in 1913 to form Bacon, Powell and Hough Lines Ltd., which was the progenitor of Coast Lines Ltd. But again, there is no direct evidence that these mergers gave coastal shipping an advantage over railways, which themselves were subject to amalgamation, for instance (although beyond our period) that in 1922 between the London and North Western and the Lancashire and Yorkshire, followed quickly by the mega-merger of the 1923 grouping.

Armstrong claims that a further response of coastal shipping to railway competition was to diversify, to provide different levels of service for different customers. At the lowest price level, where urgency was not an issue, sailing ships were available. It could be argued, however, that this was not a conscious response by management (which hardly existed in a formal sense amongst sailing ships, most of which were owned by individuals rather than companies), but a mere survival from the days when sailing ships were challenged only by canals for any form of long-distance transportation. The coastal sailing ships which survived, along with their often-traditional family owners who could not afford or envisage building anything other

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143. Armstrong, J. and Stevenson J., 'Liverpool to Hull – by Sea?' *The Mariner's Mirror* 1997; **83**: 150-168.

than small wooden sailing vessels,[144] were increasingly driven into niche markets, like the well-documented carriage of bricks and earthenware products out of Connah's Quay.[145] The east coast screw colliers which developed in the 1850s, and the steamers which followed them into other bulk trades, certainly were the result of innovative shipbuilders, plus a few venturesome owners, looking to move bulk goods more efficiently than by sailing ship, in the former case being stung into doing so by railway competition.

The early development of the coastal bulk carrier in the east coast coal trade was said to have been born out of railway competition to sailing colliers.[146] Certain areas of coastal shipping - the routes across the Irish Sea for instance - did not experience rail competition, and it would be instructive to compare the fortunes of bulk carriers on these routes with those on purely coastal routes where they were in direct competition with railways.

There is evidence that the requirements of shippers and consignees of cargoes influenced the type of vessel which carried that cargo. For instance, a large industrial undertaking such as a London gas company came to require regular, uninterrupted deliveries of coal, and this favoured the steam collier which could more or less guarantee such deliveries whatever the weather.

144. Wooden coastal sailing ships continued to be built in the UK up until the First World War, for example, the *P.T. Harris* at Appledore (Greenhill, B., *The Ship: The Life and Death of the Merchant Sailing Ship* (London, 1980), page 48) and *Gestiana* at Porthmadog in 1913 (Hughes, E. and Eames, A. *Porthmadog Ships* (Caernarfon, 1975), page 198).
145. For instance, Armstrong, J., 'Management response in British coastal shipping companies to railway competition.' page 24; Armstrong, J. and Fowler, D., pages 113-33; and Coppack, T., *A Lifetime with Ships* (Prescot, 1973).
146. Palmer, C.M., 'On the construction of iron ships and the progress of iron shipbuilding on the Tyne, Wear and Tees.' *Report of the British Association for the Advancement of Science for 1863,* 694-701.

Perhaps the most extreme example of the consignee dictating the design of a vessel was the up-river collier, with low superstructure, and masts and funnel hinged, all to allow passage under bridges on the Thames or its tributary Bow Creek to carry coal to local gas works and, later, power stations.[147]

The exact role of gas companies in encouraging the early growth of the steam collier fleets has not been quantified, and the lack of such a major consumer, demanding regular deliveries, may well have slowed the development of major bulk trades other than on the east coast. For at the other extreme to the large gas company was the coal merchant in a small port who might need just one consignment each winter, and for whom speed or regularity was not an issue, just price and possibly the size of the cargo, probably favouring sail. As well as the consignee, the relationship between the shipowner and the coal fitters, factors and merchants during the period needs to be reviewed.

With the neglect of the coastal bulk trade by historians, there is much that needs to be investigated in order to better understand how, over half a century, the steamship slowly but inexorably drove out the sailing ship from this important sector of shipping.

147. See Chesterton, D.R. and Fenton R.S.; Craig, R., *The Ship: Steam Tramps and Cargo Liners 1850-1950* who incorrectly cites the *Vane Tempest* of 1884 as the first of the breed, and Macrae, J.A. and Waine, C.V. who include a complete list of up-river colliers, the earliest of which is the *Westminster* of 1878.

CHAPTER THREE: DEVELOPMENTS THAT PRODUCED THE STEAM BULK CARRIER IN THE 1850s

Introduction

This chapter chronicles the emergence of the steam bulk carrier, through vessels which failed for various reasons in the 1840s until technical and operational success was achieved in the 1850s. The development of the four basic technical characteristics of the steam bulk carrier are considered: the iron hull, the steam engine, screw propulsion and facilities to carry water as ballast. The chapter aims to explain why success was not achieved until the 1850s, when much of the necessary technology had been available for some years.

Sources

Sources include contemporary technical journals and textbooks and work by recent historians. The latter were found, on the whole, to be more useful, providing a historical perspective on changes in technologies which contemporary sources lack.[1] Nonetheless, the latter provide useful data on individual ships, allowing comparisons to be made over time. Registration data and crew agreements have also been used extensively,

1. For instance, Rankine, W.J.M., *Shipbuilding, Theoretical and Practical* (London, 1866) is particularly disappointing, its section on engines being largely a theoretical exposition on thermodynamics. Another contemporary work, Burgh, N.S. *Modern Marine Engineering* (London, 1872) deliberately ignores historical aspects.

both to assign a vessel to the coal trade, and also to determine the dates of completion and loss of vessels.

Early attempts to produce a steam bulk carrier

During the 1840s there are a number of documented attempts to build a screw collier. For various technical and commercial reasons, few of these vessels were a lasting success.

First and best-documented of these is the *Bedlington*, completed on the Tyne in September 1842.[2] Quite apart from an iron hull and a steam engine (which was of the side-lever type, used in paddle steamers) she embodied three major innovations: water ballast tanks, twin screws, and three lines of rails laid in her hold to accommodate coal-laden railway wagons. Her purpose was to carry coal from the Bedlington Colliery's jetty on the River Blyth, to South Shields on the Tyne, where it was transhipped to sailing colliers to be conveyed to markets in the south. Although she achieved this purpose for four years, repairs needed were both expensive and so frequent that she must have been out of service for long periods. It seems that in 1846 the owners decided not to return the *Bedlington* to service after one of the more damaging of

2. Martin, S.B., and McCord, N., 'The Steamship Bedlington, 1841-54'. *Maritime History*, 1971, 1, No. 1, pages 46-72. Registration documents in National Archives BT107 give a date for issuing of a builder's certificate of 22nd September 1842, although Martin and McCord indicate she was completed in 1841.

several strandings in the difficult-to-navigate River Blyth. She did not see further service in the coal trade.

Next in order of documented attempts at screw collier construction is the *Q.E.D.* built at Walker-on-Tyne in 1844.[3] She was much more typical of later colliers than *Bedlington*, having holds into which coal was tipped conventionally. Notably, she was fitted with what sounds like a double-bottom to carry water ballast, although details are very sparse.[4] However, her steam engines were of only 20 horse power, scarcely sufficient to drive her at five knots (like other early colliers, she carried a full set of sails), and the engine was probably fitted mainly to pump out the water ballast. Indeed, it was reported as being 'adequate to discharge her water ballast when she arrived in harbour'; not a great testimony to its power. In contrast, the engines of *Bedlington* were rated at 60 horse power.[5] The engine of *Q.E.D.* was either inadequate or unreliable, as in January 1846 - only 14 months after she had been built - she was re-registered after her machinery had been removed by her owner and

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3. Macrae, J.A. and Waine, C.V., *The Steam Collier Fleets* (Albrighton, 1990), page 12.
4. *Illustrated London News* 28th September 1844, reproduced in Macrae, J.A. and Waine, C.V., page 9.
5. Horsepower figures quoted on registration documents for early steamers need to be treated with caution, as they were arrived at from applying a mathematical formula rather than by measurement, as was later done with indicator diagrams and brakes. This leads to some anomalies: replacement engines, although usually both more powerful and much more efficient, are often rated at the same, or even lower, horsepower than the machinery they replaced.

builder.[6] Trading henceforth as a pure sailing vessel, *Q.E.D.* was lost off the mouth of the Seine in 1855.

Descriptions of the *Experiment* of 1845 are at odds: both an iron and a wooden hull are described, and she is said to have been a collier[7] but actually carried general cargo and passengers between Sunderland and London until her loss in 1848.

The *Conside* of 1847 was evidently conceived as a collier[8] but was placed into regular liner trades between Leith and Hamburg immediately on completion.[9] She was lost in 1852.

The name of the Clyde-built *Collier* of 1849 leaves no doubt about her intended trade, but again commercial pressures led her to be employed on regular general cargo routes. She was completed in January 1949, but was not registered until 29th April 1850.[10] The 15 month delay suggests difficulty in finding a buyer, and her initial owner, an associate of the London, Brighton and South Coast Railway Company, placed her into a regular service on the English Channel, sailing twice weekly between Shoreham and Jersey[11]. *Collier* survived until 1914, in the latter part of her long life undoubtedly carrying the cargo for which she had been

6. Craig, R., 'Aspects of tramp shipping and ownership', in: Matthews, K. and Panting, G. eds. *Ships and Shipbuilding in the North Atlantic Region* (St. John's, Newfoundland, 1978), page 214.
7. Macrae, J.A. and Waine, C.V., page 12; Craig, R., *The Ship: Steam Tramps and Cargo Liners 1850-1950* (London, 1980), page 5.
8. Macrae, J.A. and Waine, C.V., page 12.
9. Crew agreements in the National Archives: BT98/1354 (1847).
10. Crew agreements in the National Archives: BT98/2233 (1850).

named.

The South Wales-built *Augusta* of 1849 appears to be the only one of these early bulk carriers to have been an immediate and lasting success in her intended trade of carrying ore for ironmaster Henry W. Schneider, according to Craig.[12]

Table 3.1. Summary of documented attempts to build a screw bulk carrier during the 1840s

(Sources cited in text)

Date	Name	Builder	Length	History/fate
1842	*Bedlington*	Marshall, South Shields	135 feet	Grounded in the River Blyth and broke back in 1846.
1844	*QED*	Coutts, Walker-on-Tyne	130 feet	Engines a failure, used as sailing vessel.
1845	*Experiment*	Rountree, Sunderland	103 feet	Wooden hull; lost by fire 1848
1847	*Conside*	Marshall, South Shields	106 feet	Used immediately in liner trade, Leith to Hamburg.
1849	*Collier*	Reid, Port Glasgow	95 feet	Used immediately in liner trade, Newhaven to Dieppe
1849	*Augusta*	Sturge, Swansea	140 feet	West coast iron ore. Survived until 1880s

Successful designs of the 1850s

The early 1850s saw determined, and successful, efforts to build a commercially and technically viable screw collier. Shipbuilder and coal owner Charles Palmer, writing in 1863, suggested that the impetus for

11. Crew agreements in the National Archives: BT98/2233 (1850).
12. Craig, R., 'Aspects of tramp shipping and ownership', page 210.

this came from growing competition from railways, with the aim of making it more efficient and therefore cheaper to carry coal by sea from the Tyne and Wear to London.[13]

Shipbuilders on the Tyne, the Mersey, the Dee, the Thames, the Clyde, the Tees and the Wear all contributed to the effort to produce a steam-powered collier. The first to emerge, although only by a short head, was the *John Bowes* of 1852 built by Charles and George Palmer's newly-set up Jarrow yard.[14] Launched on 30th June 1852 and registered on 24th July 1852, *John Bowes* set out from the north east on her first voyage on 27th July. She loaded 500 tons of coal on the Wear, delivered it in the Thames and returned to the Tyne on 3rd August. Both the launch of the *John Bowes* and her maiden arrival in the Thames were covered by the *Illustrated London News*, Charles Palmer clearly having a strong belief in, and the drive to get, publicity for his work. It was claimed that in one week the steamer had done the work which would normally take two collier brigs a month.[15]

Although Palmer's flair for publicity won him much credit for building the first successful steam collier, what may have been a

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13. Palmer, C.M., 'On the construction of iron ships and the progress of iron shipbuilding on the Tyne, Wear and Tees.' *Report of the British Association for the Advancement of Science for 1863,* pages 694-701.
14. Craig, R., *The Ship: Steam Tramps and Cargo Liners 1850-1950* (London, 1980), page 7. *John Bowes* was the second vessel to be launched by Palmers; the iron paddle tug *Northumberland* was their yard number 1.

technically more advanced steamer entered service only a month later, on 25th August 1852, the *Haggerston* built by Thomas Vernon and Son of Liverpool.[16] It is not clear whether *John Bowes* had any provision for carrying water ballast when built, but it is known that *Haggerston* was fitted with a double-bottom to carry water ballast when sailing light. The importance of water ballast, and the intense development work which went into refining a system to carry it, is discussed at length later in this chapter. *Haggerston*, named after the site of a London gas works, has not received the attention due to her as a pioneering collier, possibly due to her very short career: she was lost off Flamborough Head at the end of 1852.[17] A sister ship, the *Hunwick*, was completed in November 1852 for the same owner, Thomas Gibson of London.[18]

A fourth steam collier, the *Lady Berriedale*, was completed on the Thames by John Scott Russell in January 1853.[19] Although her construction may have been stimulated by the completion of the *John Bowes*, typical building times suggest she was begun, and was certainly planned, before mid-1852. Scott Russell was probably the leading naval architect of his day, and the ambition which marked his career suggests

15. This figure is widely quoted and probably originates with Charles Palmer; see for instance Macrae, J.A. and Waine, C.V., page 13; and also Bowen, F.C. (writing as FCB), 'Ships that made history: V the *John Bowes'. Shipbuilding and Shipping Record* 30th September 1937, 421-2.
16. Registration papers in the National Archives, CUST 130/45, Port Number 298/1852.
17. Registration papers in the National Archives, CUST 130/45, Port Number 298/1852.
18. Registration papers in the National Archives, CUST 130/45, Port Number 415/1852.
19. Registration papers in the National Archives, CUST 130/45, Port Number 19/1853.

that the challenge of building a successful steam collier appealed to him as an exercise in engineering.[20] Certainly, his efforts to solve the water ballast problem continued, although they were ultimately unsuccessful, as discussed later.

The three vessels mentioned were the precursors of an explosion in steam collier building. Table 3.2 lists the steam colliers which can be confidently identified as completed during the 1850s. It is apparent that, although the Tyne (thanks largely to Palmers' efforts) and the Thames predominate, all the major shipbuilding rivers (and one rather minor one, the Dee), contribute vessels. The total number, over 70, built within a few years of the pioneering vessels in 1852, is impressive, as is the output in 1853 (13 vessels registered), 1854 (17) and 1855 (19). The success of these ships helped establish a number of their builders as major ship constructors: Laing at Sunderland, Mitchell at Low Walker on the Tyne, and most spectacularly, Palmers at Jarrow on the Tyne. The last-named (who built 24 of the 71 colliers listed in Table 3.2) used the success of *John Bowes* to win him orders both for colliers and other types of iron steam ship, although he often had to invest heavily in the ships or their owning companies to achieve this. By taking over other yards on the Tyne, adding an engine-building shop and an iron works on his

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20. Emmerson, G.T., *John Scott Russell: a Great Victorian Engineer and Naval Architect* (London, 1977).

Jarrow site, and opening his own iron ore workings in North Yorkshire, he built his company into one of the world's biggest shipbuilders, capitalised at one million pounds when floated in 1865.[21]

Clearly, the steam screw collier was a vessel whose time had come in the 1850s. The remainder of this chapter considers the individual technological developments that were necessary for these successful steam colliers to be built.

21. Clarke, J.F., *Building Ships on the North East Coast: Part 1 c 1640-1914*. (Whitley Bay, 1997), page 120 et seq.; Rowe, D.J. 'Charles Mark Palmer'. In Jeremy D.J., ed. *Dictionary of Business Biography*, vol. 8, 515-521. Born in 1822, Charles Palmer was already a successful businessman when he and his brother George bought an existing wooden shipbuilding yard at Jarrow in 1851. He was a partner with local coal owner John Bowes in various successful mining and coking coal ventures, including the Marley Hill Coal Company. Despite giving his name to the ship, John Bowes never had a financial stake in the *John Bowes*, according to its registration documents.

Table 3.2: Chronological list of screw colliers built from 1852 to 1859

Name	*Launch*	*Completion*	*Registration*	*Builder*	*Where*
JOHN BOWES	1852.06.30	1852.07.19	1852.07.24	Palmer	Tyne
HAGGERSTON		1852.08.25	1852.08.30	Vernon	Mersey
HUNWICK		1852.11.17	1852.11.23	Vernon	Mersey
LADY BERRIEDALE		1853.01.13	1853.01.15	Scott Russell	Thames
WILLIAM HUTT	1852.12.07	1853.02.17	1853.03.08	Palmer	Tyne
LADY ALICE LAMBTON		1853.03.23	1853.04.05	Marshall	Tyne
COUNTESS OF STRATHMORE	1853.03.12	1853.04.11	1853.05.11	Palmer	Tyne
RAJAH	1853.01.01		1853.06.18	Mare	Thames
NORTHUMBERLAND		1853.05.19	1853.06.25	Palmer	Tyne
EAGLE		1853.07.06	1853.07.19	Scott Russell	Thames
SIR JOHN EASTHOPE	1853.05.19	1853.06.27	1853.07.26	Palmer	Tyne
CHANTICLEER		1853.07.26	1853.08.18	Denny	Clyde
DURHAM	1853.06.29	1853.08.10	1853.08.30	Palmer	Tyne
CAROLINE		1853.10.01	1853.10.07	Scott Russell	Thames
JARROW	1853.08.13	1853.10.17	1853.11.14	Palmer	Tyne
FALCON		1853.12.10	1853.12.14	Scott Russell	Thames
HAWK		1854.01.20	1854.02.08	Scott Russell	Thames
MARLEY HILL	1853.08.13	1854.02.02	1854.02.09	Palmer	Tyne
ROSS D. MANGLES	1854.02.03	1854.05.04	1854.05.18	Palmer	Tyne
NICHOLAS WOOD	1854.05.15	1854.05.15	1854.06.03	Palmer	Tyne
UNION		1854.06.07	1854.06.16	Lungley	Thames
BLACK PRINCE		1854.08.11	1854.08.28	Vernon	Mersey
GREAT NORTHERN		1854.08.24	1854.08.31	Laing	Wear
BRITON		1854.08.07	1854.09.26	Samuda	Thames
FIREFLY		1854.09.01	1854.09.30	Vernon	Mersey
SAXON		1854.08.07	1854.10.10	Samuda	Thames
PIONEER			1854.11.13	Scott Russell	Thames
NORMAN		1854.10.24	1854.11.24	Lungley	Thames
HETTON		1854.09.22	1854.11.28	Mitchell	Tyne
IMPERIAL		1854.11.28	1854.12.06	Scott Russell	Thames
EARL OF DURHAM		1854.07.04	1854.12.13	Mitchell	Tyne
COCHRANE	1854.06.14	1854.09.15	1854.12.19	Palmer	Tyne
BLACK BOY	1854.09.21		1854.12.28	Palmer	Tyne
WHITLEY PARK		1854.12.22	1854.12.29	Palmer	Tyne
SAMUEL LAING	1854.11.14	1854.11.15	1855.01.02	Palmer	Tyne
BLACK SEA		1854.12.29	1855.01.04	Palmer	Tyne
CHESTER		1854.12.09	1855.01.17	Cram	Dee
KILLINGWORTH		1855.01.16	1855.01.17	Mitchell	Tyne
NEW PELTON		1855.01.01	1855.01.26	Scott Russell	Thames
NORMANBY	1855.01.20	1855.03.01	1855.03.05	Palmer	Tyne
DANE			1855.03.16	Lungley	Thames
WEARMOUTH		1855.03.15	1855.03.17	Laing	Wear
COUNTESS OF DURHAM		1855.05.22	1855.04.19	R, Duck	Tees
DERWENT		1855.02.22	1855.04.24	Cramm	Dee
BLACK DIAMOND	1855.05.01	1855.06.07	1855.06.11	Laing	Wear
GEORGE HAWKINS	1855.05.05	1855.07.10	1855.08.30	Palmer	Tyne
EARSDON	1855.07.16	1855.08.21	1855.09.10	Palmer	Tyne
VEDRA		1855.09.03	1855.09.18	Sunderland	Wear

RECHID		1855.09.20	1855.10.04	Richardson	Tees
SARDINIAN	1855.09.12	1855.10.01	1855.10.20	Palmer	Tyne
HUTTON CHAYTOR	1855.06.22	1855.10.15	1855.10.24	Palmer	Tyne
CARBON		1855.09.03	1855.11.08	Clayton	Mersey
BERWICK		1855.11.02	1855.11.08	Scott	Clyde
VULTURE	1855.10.23	1855.12.13	1856.01.10	Laing	Wear
TYNE	1856.01.04		1856.00.00	Palmer	Tyne
GENERAL CODRINGTON		1855.12.14	1856.01.05	Palmer	Tyne
FLORENCE NIGHTINGALE		1856.01.22	1856.01.21	Richardson	Tees
MARMORA	1856.01.29	1856.02.00	1856.02.14	Palmer	Tyne
EUPATORIA		1856.03.22	1856.04.03	Mitchell	Tyne
WILLIAM FRANCE			1856.05.06		Clyde
VISCOUNT LAMBTON	1856.02.07		1856.05.14	Rich, Duck	Tees
CONTEST			1857.00.00	Simons	Clyde
RESOLUTE			1857.04.11		Clyde
SEATON	1857.01.08	1857.02.06	1857.05.16	Palmer	Tyne
LYON	1857.05.00	1857.04.04	1857.05.16	Mitchell	Tyne
WILLIAM CORY	1857.05.23	1857.07.31	1857.07.27	Mitchell	Tyne
LONDONDERRY		1857.08.11	1857.08.14	Pile	Tees
HERCULES	1857.	1857.08.19	1857.08.22	Laing	Wear
ROUEN		1857.09.05	1857.09.10	Palmer	Tyne
LAMBTON		1857.11.30	1857.12.05	Mitchell	Tyne
JAMES DIXON	1859.08.20	1859.09.02	1859.09.13	Palmer	Tyne

Note on table 3.2

The data for this table comes primarily from registration documents plus a number of other sources, details of which are given on the individual ship data sheets included in the appendix. Of the three dates listed, registration date is that most consistently available, always being included on the vessel's registration document, and the ships are shown in order of this date. The dates of completion listed are, in fact, the dates on the Builder's Certificates which are presented to the registrar when a ship is initially registered, and this date is often recorded on the registration form. The registration and Builders Certificates' dates are usually only one to two weeks apart. Launch dates are not officially recorded, and those quoted have been taken from the work of a number of researchers, who have found them in shipbuilders' records or in local newspapers.

The iron hull

All the screw colliers documented during the work for this thesis had iron hulls. As wooden ship construction was still commonplace in the 1840s and 1850s, and indeed general for the sailing ships that the screw colliers were designed to replace, it is worth examining why it was necessary to employ iron with its disadvantages of cost and the need for specialised working skills. Not the size of the early screw colliers (around 150 feet), nor their use of steam engines driving a screw, nor their design for the carriage of heavy cargoes can fully explain why they were built of iron. Ships much longer than 150 feet have been routinely constructed of wood; seagoing sailing vessels of over 200 feet being built in the late eighteenth century, and even longer ones when sail and its builders were feeling the effects of steam competition in the late nineteenth century.[22] According to Peebles, the screw 'imposed intolerable stresses on wooden hulls',[23] whilst Lyons wrote that wood was 'too flexible for long, rigid drive shafts, which needed careful alignment, and did not readily provide water-tight glands for the shaft to pass through.'[24] However, steam engines driving screws continued to be fitted to wooden-hulled fishing vessels well into the twentieth century,

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22. Griffiths, D., Lambert, A., and Walker, F., *Brunel's Ships* (London, 1999), page 57.
23. Peebles, H.B., 'A study in failure: J. & G. Thomson and shipbuilding at Clydebank, 1871-1890', *Scottish Historical Review*, Vol. 69, No. 1 (April 1990), pages 22-48
24. Lyon, D., *The Ship: Steam, Steel and Torpedoes* (London, 1980).

for instance the East Anglian drifters which measured up to 120 feet in length.[25] These fishing vessels carried relatively small cargoes, and the stresses brought about by loading and unloading several tons of herring can hardly be compared with those of having a hundred tons of coal teemed into a hold. Yet, the wooden sailing colliers survived such treatment, often for many decades. There is also the example of the small, wooden-hulled coastal schooner or ketch which survived into the twentieth century and had its life prolonged by fitting an internal combustion engine. These timber-built vessels both withstood the vibration inherent in their often crude engines and endured continual rough loading and unloading in coastal bulk trades. What, then, were the reasons for adopting iron hulls?

An iron hull can carry more cargo than a wooden vessel of the same overall dimensions. The plates that make up the shell of an iron hull can be far thinner than the wooden planking of its timber counterpart, and the frames, beams and stringers which support the outer skin can also be much reduced in size when iron is used. It has been estimated that the space available within a wooden hull would be only 80 per cent of the overall volume of the hull, whereas this could be raised to 96 per cent with an iron hull, so that the latter could carry 20 per cent

25. See for instance, Daniels, S.G., 'Steam drifters' *Ships in Focus Record* No. 12, 2000, pages 236-243

more cargo.[26] Early screw collier builders such as Scott Russell, Lumley and Samuda on the Thames, and Thomas Vernon in Liverpool were experienced in iron shipbuilding and were undoubtedly aware of this advantage.

It is also likely that the greater inherent strength of the iron hull appealed to the builder of screw colliers. The butts where adjacent timber planks are joined represent a source of weakness in a wooden hull. These butts must therefore be kept as far apart as feasible so that the timber used for planking should be as long as possible, 36 feet being regarded as the shortest acceptable plank.[27] Similarly, for larger vessels the frames could rarely be constructed from single pieces of timber and had to be built up from smaller pieces, with inevitable weakness where the individual pieces were joined. Drilling holes for nails and bolts weakened timber more than it did metal, as the holes severed the fibres that gave the wood its strength. With iron construction the plates (although relatively short) were riveted together, and so strong was this bond that it imposed no restriction on the length of the vessel. Likewise, frames could be larger, fabricated from one or more pieces, and hence stronger. The *Great Eastern*, a contemporary of the early screw colliers (it was constructed between 1853 and 1858 at a yard that was also

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26. Griffiths, D., Lambert, A., and Walker, F., *Brunel's Ships* (London, 1999), pages 56-57.
27. Griffiths, D., Lambert, A., and Walker, F., page 53.

building screw colliers, that of John Scott Russell at Millwall), showed that iron made it possible to build vessels of a previously unimaginable length, 600 feet. Whatever its commercial failings, the *Great Eastern* was completely successful as an iron structure.

Thus, although it was feasible to build from wood ships over 200 feet in length, an iron hull had the advantage of strength. Probably an even more important consideration was that iron construction allowed the hatchways to be much larger without seriously weakening the hull structure. Hatches on wooden ships represented points where the deck planks, and other longitudinal members, had to be cut short. They were a point of weakness and were kept as small as possible. The restricted access to the hold limited the speed of loading and - even more - unloading. Crucial to the success of a screw collier was rapid unloading and discharge, and hence large hatches were essential. A notable feature of the pioneer iron screw collier *John Bowes* was a single 60-foot hatch, representing 40 per cent of the ship's length.[28]

The evolution of shipbuilding in iron was relatively slow. There is some contention as to when iron was first used for hull construction (it had long been used for ancillary items, such as anchors). Most authors[29]

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28. Bowen, F.C. (writing as FCB), 'Ships that made history: V the *John Bowes*'; Macrae, J.A. and Waine, C.V., page 13, consider this the most important feature of her design.
29. E.g. Greenhill, B., in 'Steam before the screw' in *The Advent of Steam: The Merchant Steam Ship before 1900*, page 22.

cite the steamer *Aaron Manby* of 1822 as the first sea-going iron ship. She was built in Staffordshire of quarter-inch iron plates over angle-iron frames, then knocked down and taken to London for re-assembly. *Aaron Manby* then made a passage to Paris, establishing her credentials as sea-going, but was subsequently used on the River Seine between Paris and Havre. However, iron hulls had been built and used on inland waterways long before the *Aaron Manby*. According to Kennedy, who made a painstaking study of early records of steamships, the earliest iron hulled steamer was the *Experiment*, built near Leith in 1788 by William Symington, which Kennedy also claims as the first successful British steamship.[30] Other iron hulls predating the *Aaron Manby* include a barge named *Trial*, built at Coalbrookdale, Shropshire in 1787 and quite possibly the first iron hull, and the *Vulcan*, launched on Monklands Canal near Coatbridge in May 1819.[31]

Although proven feasible by 1820, iron hulls remained very unusual before 1840. Kennedy lists some 1,200 steamships built in the UK before that date, yet only 30 were known to have been built of iron: under 3 per cent of the total of steamers, themselves representing a very small proportion of the entire output of British shipbuilding. Greenhill mentions some of the difficulties in the way of iron construction of hulls,

30. Kennedy, N.W., *Records of Early British Steamships* (Liverpool, 1933).
31. Griffiths, D., Lambert, A., and Walker, F., page 53 et seq.

including the uncontrolled and uneven quality of iron girders and plates available at the time, and the difficulty of transporting iron to shipbuilding districts.[32] He maintains that it proved possible to construct the *Great Britain* (built between 1840 and 1843 at Bristol) only because iron of an acceptable quality and price could be transported down the rivers Severn and Avon from the Coalbrookdale region of Shropshire. Others have pointed out the enormous amount of labour involved in early iron shipbuilding.[33] The blacksmiths who constructed the *Vulcan* in 1819 would have had puddled iron delivered, from which they hand-forged the plates and parts of the frames. The plates had to be cut to size using hand tools, and the holes for the rivets drilled, again by hand, with considerable accuracy to match the rivet holes in adjacent plates. Forging the plates from puddled iron meant a high likelihood of fractures, cracks and blowholes, any of which could weaken the plate or even make it unusable. For this reason it was difficult to obtain good iron plates longer than 9 to 10 feet, and many yards used smaller ones.[34] It was only towards the 1870s, with advances in iron-making and plate-rolling technologies, that plates of up to 45 feet in length came into common use. As a result, early iron vessels had many vertical butts and horizontal seams. However, early iron ships did have a considerable

32. Greenhill, B.
33. Griffiths, D., Lambert, A., and Walker, F., page 61.

advantage in longevity; probably because the process for manufacturing the iron plates ensured that they resisted corrosion, and Griffith *et al* suggest that whilst a steel hull could last 15 to 25 years, an iron hull may still be in good condition up to 100 years after construction.[35]

Another factor in the slowness of the growth of iron hull construction was that few existing shipbuilders could, or were prepared to, make the transition from wood to iron. Arnold has pointed out that the development of iron shipbuilding relied on transfer of technology from land to marine use, and that shipbuilding in iron challenged existing approaches to shipbuilding rather than adapted them.[36] This meant that many of the yards initially building in iron (e.g. Napier; Tod, McGregor and Wingate on the Clyde, Laird and Vernon on the Mersey) were newly set up to do so, rather than being yards building in wood that evolved techniques using iron. The organisations with experience in working with iron included marine steam engine manufacturers, and hence a number of these diversified into shipbuilding, including Henry Maudslay and Rennie on the Thames, and Tod and MacGregor and Robert Napier on the Clyde.[37] New skills had to be developed in shipyards which intended to build in iron, including those of the loftsmen who prepared

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34. Griffiths, D., Lambert, A., and Walker, F., page 62.
35. Griffiths, D., Lambert, A., and Walker, F., page 61.
36. Arnold, A.J. *Iron Shipbuilding on the Thames 1832-1915* (Aldershot, 2000), page 10
37. Arnold, A.J., pages 11 and16

full-size templates of each part to be made from iron, and the platers who cut the plates and bent them into often complex shapes.[38]

The completion of the *Great Britain*, and her survival over many winter months following her stranding in Dundrum Bay, is considered to have given a considerable impetus to the use of iron.[39] Possibly as a result, the 1840s saw iron shipbuilding expanding dramatically, with eight times as many ships being built of iron in that decade as in the 1830s.[40] In a survey of the industrial background to the development of the steamship, Starkey considers that by 1850 there was a core of accumulated expertise and productive capacity within the related industries of iron making and engineering.[41] Even so, iron accounted for only 9.5 per cent of UK ship construction in 1850.

By the 1850s, when steam colliers began to appear, shipbuilding in iron was well beyond its infancy, and there was sufficient confidence in its capabilities that mammoth projects such as the *Great Eastern* could be attempted. Nevertheless, as the lack of capacity for producing good-sized iron plates indicates, iron shipbuilding had not yet fully developed and it had certainly not been wholeheartedly embraced by shipowners. It was an adolescent industry which, although it could do many things,

38. Griffiths, D., Lambert, A., and Walker, F., page 56.
39. Corlett, E.C.B. *The Iron Ship* (London, 1990).
40. Slaven, A., 'The shipbuilding industry', in R. Church, *The Dynamics of Victorian Business* (London, 1980), pages 107-125

could not yet do them with the efficiency that would allow it, by the late nineteenth century, to completely oust wooden construction for major vessels.

Screw propulsion

The hull of the paddle steamer was not well suited to carrying bulk cargoes. For seagoing paddle steamers, the paddles - and hence the engines - had to be mounted more-or-less centrally in the hull. Thus, the engines took up the part of the hull which was most useful for carrying a bulk cargo.[42] A further problem was that the depth to which paddles were immersed was critical to their efficiency.[43] If a paddle steamer carried a bulk cargo, immersion of the paddles would vary greatly between the laden and the empty state, a problem which could only be overcome by carrying a weight of ballast equivalent to the full cargo capacity, an option which was expensive both in terms of cost of the ballast and in terms of the extra fuel required to propel the ballasted vessel. Neither of these factors was a problem for paddle steamers involved in regular trades. They carried passengers or relative light, high-value and perishable cargoes such as mail or foodstuffs, which could be accommodated or stowed in the parts of the hull fore or aft of

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41. Starkey, D.B., 'Industrial background to the development of the steamship' in: Greenhill, B. (ed.), *The Advent of Steam: The Merchant Steamship before 1900* (London, 1993), page133
42. Macrae, J.A. and Waine, C.V., page 11.

the engines. As passengers and goods tended to be carried on each leg of the voyage, any small variations in depth of immersion of the paddles would not have had a significant effect on efficiency.

Use of screw propulsion overcame both problems. For the relatively small bulk carrier, use of a screw meant the engines could be placed well aft, leaving the central and most commodious part of the hold for cargo. Even more importantly, it also allowed a long, clear hold and hatchway for loading and unloading of a bulk cargo, factors in expediting turnround in port. Later screw colliers were built with their engines amidships, but this was mainly for larger ships where designers were concerned with placing the weight of the engine centrally to overcome problems of stress and trim. Taking the story forward into the latter part of the twentieth century, engines-amidships vessels were eventually made obsolete by the modern bulk carrier, which invariably has its engines placed aft. Provided it is fully submerged, the depth to which a screw is immersed makes no difference to its efficiency, so it can be equally effective whether the vessel is laden or light. Placing the engines aft trims the vessel by the stern, keeping the screw immersed. A screw collier did need some ballast when steaming light, as discussed later in

43. Corlett, E.C.B,. 'The Screw Propeller and Merchant Shipping 1840-1865' In Greenhill, B. (ed.), *The Advent of Steam: The Merchant Steamship before 1900* (1993), page 85

this chapter, but much less than would be needed to keep paddles immersed.

Corlett has summarised the development of the screw.[44] Although very old in concept, the screw was only slowly refined to propel ships. Hand-driven screws were applied in Bushnell's submarine *Turtle* of 1776, but the first practical screw was that patented in 1836 by Francis Pettit Smith, with Ericsson following very closely with a patent for a rather different, but equally successful, screw. The first large vessel fitted with Smith's patent screw, the *Archimedes* of 1838, was extremely successful, first circumnavigating England, Wales and Scotland, and then voyaging to Oporto, the first sea voyage ever made by a screw vessel. These demonstrations left no doubt as to the efficiency and practicality of the screw, and a call at Bristol by *Archimedes* in 1840 persuaded Brunel to alter the design of his *Great Britain* (which was already under construction) from paddle- to screw-propulsion. Corlett describes the *Great Britain* as the first modern ship, and indeed her combination of iron hull and screw propulsion was a remarkable pioneering achievement. It is necessary, however, at the risk of seeming to cavil, to note that the *Great Britain* was not a resounding commercial success, at least initially. A very brief career in her intended role as a trans-Atlantic

44. Corlett, E.C.B,. 'The Screw Propeller and Merchant Shipping 1840-1865', pages 83-105

liner was followed by a lengthy, and probably more successful, period in the Australian trade, after which her engines were removed and she operated as a pure sailing ship until hulked on the Falklands.[45]

The examples which Corlett gives do not suggest that the screw was adopted with great alacrity, although his focus is on the technical development of the screw. After the *Great Britain*, completed in 1843, the next screw-driven commercial steamers he mentions are the *Sarah Sands* of 1847, basically an emigrant-carrying sailing ship with auxiliary engines, the *City of Glasgow* of 1850, a passenger liner that was successful on trans-Atlantic routes without the subsidy customary at the time, and *Himalaya* built in 1853 for P&O's service to the Far East. However, like many other authors, Corlett pays scant attention to coastal craft.[46] It is apparent from the work of Waine[47], Craig[48] and Martin[49] that attempts were being made to apply the screw to coastal bulk carriers as early as 1842 with the *Bedlington*.

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45. Griffiths, D., Lambert, A., and Walker, F., page 133 et seq.
46. Indeed, the volume in which his chapter appears, Conway's *History of the Ship: The Advent of Steam* seems entirely obsessed with large passenger ships, and neglects the much more numerous bulk carrier, ocean-going or coastal.
47. Macrae, J.A. and Waine, C.V., chapter 1.
48. Craig, R., *The Ship: Steam Tramps and Cargo Liners 1850-1950.*
49. Martin, S.B. and McCord, N.

The steam engine

The steam engine made the screw collier independent of wind and tide, although the evolution of the engine into a form that could propel colliers was dependent upon the development of the screw.

The first successful steam engine is recognised as being that installed by Thomas Newcomen at a Staffordshire colliery in 1712.[50] Subsequently, many individuals helped develop the steam engine, most notably James Watt who introduced, amongst other improvements, the separate condenser to improve efficiency and, about 1780, developed an engine that produced the rotary power that would be needed to propel vehicles and ships. As with the development of the steam engine, a number of individuals contributed to its application for marine propulsion: 'the creation of the steamship appears to have been an achievement too gigantic for any single man' wrote John Scott Russell.[51] Different authors cite various starting dates,[52] and it is clear that development work was continuing, in parallel and probably in ignorance of other efforts, at least in the USA,[53] Scotland,[54] and England[55] in the

50. Griffiths, D., *Steam at Sea: Two Centuries of Steam-powered Ships* (London, 1997), page 3.
51. Dyer, H., 'The first century of the marine engine' *Transactions of the Institute of Naval Architects*, 1889; **30**: page 87.
52. For instance, Griffiths, D., *Steam at Sea: Two Centuries of Steam-powered Ships* and Kennedy, N.W., *Records of Early British Steamships* (Liverpool, 1933). Griffiths' painstaking 1997 study is probably the best modern exposition, but he seems to have been ignorant of Kennedy's monumental researches into early British steamships undertaken during the 1920s and 1930s: Griffiths, nonetheless, has unearthed details of British vessels unknown to Kennedy.
53. Griffiths, D., *Steam at Sea: Two Centuries of Steam-powered Ships* , page 4, citing the work of Fitch and Voight from 1786.

late 1780s. Griffiths points out that progress in the UK was stifled by patent protection on the steam engine given to Watt and his partner Matthew Boulton, and only when this expired in 1800 was advancement rapid, especially on the Clyde. Landmarks included Henry Bell's steamer *Comet* which opened a service between Glasgow and Greenock in 1812, David Napier's *Rob Roy* which operated across open sea between Greenock and Belfast in 1818, and the first crossing of the Atlantic by a steamship in 1819 by the *Savannah*, although its steam engine was a low-powered auxiliary in use for only 85 hours on a 28-day crossing.[56]

Improvements to the steam engine involved increasing the efficiency by which steam was generated though better boiler design, improving thermodynamic efficiency by modifying the way the steam was used, and extending reliability by development of bearings, cylinders and other moving parts. These enhancements were equally relevant to stationery, railway locomotive and marine steam engines.

Improving the thermodynamics involved utilising the expansive power of steam. Initially, the practice was to admit steam to the cylinders throughout the piston stroke.[57] It was then exhausted to the condenser at only slightly less pressure than it was produced by the

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54. Kennedy, N.W., page 14 and Griffiths, D., page 4 citing the work of Miller, Symington and Taylor on Dalswinton Loch, near Leith from 1788.
55. Kennedy, N.W., page 14 citing the Furness and Ashton experiments at Hull in 1789
56. Griffiths, D., pages 6-9

boiler, which was clearly wasteful, so efforts were made to harness the expansive power of the steam. Admission to the cylinder was cut off at a certain point in the piston stroke, after which the expansion of the steam already admitted drove the piston. This was at the expense of some power, but this was more than outweighed by significant savings in the use of steam and hence of the fuel required. When expansive working was first applied, the point in the stroke at which the steam was cut off was pre-arranged, but this was not ideal for all levels of engine load, and in the 1830s methods of allowing cut off to be varied were devised. For the *Great Western* of 1837 Brunel specified machinery that would allow nine levels of cut off. Various types of valve gear, such as Stephenson's link motion, evolved to achieve variable expansive working.

Expansive working encouraged a further very important development, the gradual increase in the pressure of steam fed to the cylinders. The greater the pressure of steam, the more its expansive power, but generating steam at higher pressures required developments in the construction and design of boilers. The earliest steamers, such as the *Charlotte Dundas* of 1801, had nothing more sophisticated for a boiler than a cylinder containing water stood on firebricks under which a fire was lit.[58] By about 1820, the flue-type boiler was in general marine use.

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57. Griffiths, D., page 10
58. Griffiths, D., page 58

The hot gases from the burning coal were conducted from furnace to funnel through a maze of flues designed to maximise the opportunity for heat to be transferred to the iron or copper surface of the boiler.

An advance in efficiency of boilers came through the adoption of surface condensers, as patented by Hall in 1834. Prior to this, the steam exhausted from the cylinders was condensed by playing on it jets of sea water. Thus, the initially fresh water was quickly contaminated by salt and, when fed back into the boiler, caused the build up of scale on the inner surfaces, reducing the efficiency with which the heat was transferred from furnace to water, and causing corrosion which considerably shortened the life of the boiler. The boilers had to be frequently blown down to reduce this scale, temporarily reducing power and wasting hot water. In the surface condenser, cold sea water was circulated around small diameter tubes through which steam from the cylinders was passed. Pressure in the condenser was reduced by a vacuum pump. The steam was condensed without being contaminated with salt water, and - being kept in a closed system - the condensate could be fed back into the boiler without fear of scaling. However, this caused problems with corrosion in the boilers, which the salt deposits had tended to prevent, and much experimentation was required until it was discovered that fitting zinc plates in the boilers controlled corrosion.[59] A further problem was that cylinder lubricants were carried over by the steam into the condenser and tended to block the tubes.[60] This was eventually solved by fitting canvas filters. After initial enthusiasm for the surface condenser, these problems led to its temporary abandonment, and it was not readopted until around 1860.[61] The early colliers of the 1850s therefore had the crude sea-water jet condensers.

In the 1840s and 1850s, flue-type boilers began to be replaced (physically, in many early paddle steamers) with boilers with fire tubes, which were often tubular in section.[62] In these the hot gases from the furnace were conducted through tubes in the water space. This was essentially the type of boiler used in a typical steam railway locomotive, although in marine boilers the opportunity was often taken to fit a second set of flue tubes to increase heat transfer to the water. These boilers tended to be more compact, increasing the space in the hull available for cargo or passengers, and allowed higher working pressures, although this was achieved only with substantial staying of any flat surfaces of the boiler. Even so, pressures were not high: the boilers fitted in the *Great Eastern* in 1856 used a working pressure of 25 psi.[63] The *Great Eastern's* boilers probably represented the state of the art, and a screw collier built

59. Waine, C.V. and Fenton, R.S., *Steam Coasters and Short Sea Traders* (3rd ed. Albrighton, 1994), pages 36-37
60. Waine, C.V. and Fenton, R.S., page 35.
61. Griffiths, D., page 35.

at the same Millwall yard in 1852, the *Lady Berriedale*, had a boiler pressure of just 7 psi. The *Great Eastern* was also equipped with superheaters, which increased the temperature of the steam above the boiling point of water, making it drier, and less likely to condense in the cylinders.[64] However, superheating was not widely adopted until the 1860s, and Waine claims that it was not widely used in steam coasters until after the First World War.[65]

Until the late 1830s, the developers of the marine steam engine directed their efforts almost wholly to producing machinery to power paddle steamers. This produced the side-lever engine, which was almost universally adopted. It derived from early beam engines, and was particularly successful in marine applications because of its reliability and because its centre of gravity was low, ensuring stability. Other types of steam engines were later developed for use in paddle steamers, but the gradual adoption of screw propulsion from the 1840s meant the emphasis switched to development of engines suitable for driving a screw. One important example of the differences is that a speed of 20 rpm was ideal for driving paddle wheels, but screw propulsion required speeds of at

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62. Griffiths, D., page 63
63. Griffiths, D., page 63
64. Griffiths, D., page 63.
65. Waine, C.V. and Fenton, R.S., page 35.

least 60 rpm.[66] Engines turning at such speeds gave problems of vibration. Until sufficiently fast direct-drive engines were developed, the costly solution of using gearing, or chain drive, was adopted to give optimum screw speed. An interim solution was to build engines in which the cylinders oscillated.[67] This had the advantage of eliminating the need for valve gear, as the movement of the cylinders covered and uncovered the steam inlets and outlets. However, sealing the joints became more difficult as boiler pressures increased, and the oscillation of the cylinders gave significant problems of vibration as engines ran faster.

There were other problems with the adoption of the screw. The action of the turning screw exerted a force along the shaft which tended to push the engine forwards. To resist this force, thrust blocks were fitted, rigidly secured to the hull of the ship between the engine and the propellor shaft. Unlike the shaft which drove the paddles in a paddle steamer, the screw shaft protruded under water, and an efficient way of sealing it had to be devised. Corlett and Griffiths date to as late as 1854 the solution of this problem, with the introduction of the water-lubricated, lignum vitae tail shaft by the Thameside engine-builder John Penn.[68]

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66. Macrae, J.A. and Waine, C.V., page 35
67.Waine, C.V. and Fenton, R.S., page 34.
68. Griffiths, D., page 33; Corlett, E.C.B,. 'The Screw Propeller and Merchant Shipping 1840-1865' In Greenhill, B. (ed.), *The Advent of Steam: The Merchant Steamship before 1900* (1993), page 100.

By the early 1850s, when the first successful steam colliers were appearing, the design and construction of boilers and marine steam engines capable of driving screws had progressed somewhat since the pioneering decades of the 1800s and 1810s, but the growth in efficiency was very modest compared with what was to come with further improvements such as the Scotch boiler, much higher pressures, inverted engines, compounding, triple-expansion, and widespread use of superheating.[69] Thus, colliers built in the 1850s had machinery that was crude by the standards of even one decade on. This is apparent from the frequent re-engining (and even more frequent reboilering) which the pioneer vessels underwent. *John Bowes*, for instance, had her original 1852 machinery replaced in 1862, and this in turn was replaced in 1883. That the third set of machinery sufficed until she was lost in 1933 - when it was 50 years old - indicates how far the design of steam machinery had progressed in the thirty years after the pioneer colliers steamed down the east coast. As Greenhill wrote of the mid-years of the nineteenth century '...the steam engine was still an uneconomical luxury.'[70] Development of the steam engines for use in screw colliers and other coastal bulk carriers is discussed in chapter 10.

69. These developments are discussed in more detail in chapter 10.

Water ballast

To meet their high capital and running costs, steam bulk carriers had to make the maximum number of voyages in a given period. Disruption to this schedule could be caused by having to load and unload solid ballast at the beginning and end of each light voyage. After unloading on the Thames, a collier would need to take on chalk, sand or shingle, and to unload it on the Wear or Tyne before receiving a further coal cargo. Disruption would be made more severe if the steamer had to queue whilst sailing ships loaded or unloaded.

Allen, in an 1855 paper presented to the Institution of Civil Engineers comparing sailing and steam colliers, gives details of the use of sand as ballast.[71] It was usual to take on board ballast amounting to one-sixth of the weight of an average cargo. Allen estimated the cost of purchasing the sand, of loading and discharging it, and of the delay whilst doing this at three shillings per ton. He estimates that ballasting would lose a ship 40 days per year.

For a steam ship, use of water as ballast was an obvious answer, as it could be pumped in and out with a pump driven from the main engine. The first documented attempt to use water as ballast was the screw steamer

70. Greenhill, B. (ed.), *The Ship: The Life and Death of the Merchant Sailing Ship* (London, 1980), page 18.
71. Allen, E.E., 'On the comparative cost of transit by steam and sailing colliers, and on the different methods of ballasting.' *Proceedings of the Institute of Civil Engineers* XIV (1854-5), page 328.

Bedlington of 1842,[72] Slightly better documented is the auxiliary steamer *Q.E.D.* of 1844.[73] There were a number of other experiments with screw colliers in the 1840s, but there is no reference to any of these having water ballast. However, it would be surprising if the experiment tried on the *Q.E.D.* was not repeated, perhaps with a bigger or more reliable engine. Chronologically, the next reference to use of water ballast is in the brig *Benton*, dated June 1851.[74] The *Benton* had been purchased to test the ballasting method invented by Dr. David B. White of Newcastle-upon-Tyne. Collapsible rubber or canvas bags were filled with water and stowed in the hold to be filled with water for the northward passage. According to *Benton's* captain, on her first voyage with the bags, she began to fill them when bound down river off Woolwich, filling them (presumably using a hand pump) taking only one half hour. The bags were examined at intervals during the voyage, and were found to remain in perfect condition. The bags were 'started' when she arrived in the Tyne, presumably the water being allowed to empty into the bilges to be pumped over side.

Waine and Macrae refer to a sailing collier named *Temperance* which traded between Maryport and Belfast being used to try out White's

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72. Martin, S.B. and McCord, N. refer to this briefly, but give few details.
73. Hodgson, G.B., 'The genesis of the screw collier' *Nautical Magazine* LXX (1901), page 176; Macrae, J.A. and Waine, C.V., page 12. The latter cite the *Illustrated London News* of 28th September 1844, and Hodgson is probably quoting from this source.

system.[75] Hodgson quotes a letter from coal factor Hugh Taylor dated August 1852 in which he describes the savings made with water ballast over a 12-month period in the sailing collier *Devonshire*.[76] It seems that the method quickly gained in popularity, as when Allen presented a paper in February 1855 he referred to White's 'bag-water-ballast' having been fitted to nearly 50 sailing and screw vessels in the four years since its introduction in 1851.[77]

Allen's paper is an important one, as it examines different types of water ballasting arrangements, giving intimate details of equipment such as pumps. However, the author does not always display the disinterest which might be expected from a scientist. He comes out strongly in favour of bag ballast and dismisses out of hand the form of ballasting which was soon to prove most successful, tank water ballast. His frequent references to, and defence of, John Scott Russell, who was at the time building colliers with bag ballast, and his dismissal of some of Jarrow shipbuilder Palmer's developments, suggests some business connection between Allen and Russell which may have resulted in his want of objectivity.

Nevertheless, Allen's paper and the discussion which ensued over

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74. Hodgson, G.B., page 178, quoting a letter from *Benton's* master, James Storey, to a 'local newspaper' dated 25th June 1851.
75. Macrae, J.A. and Waine, C.V., page 16.
76. Hodgson, G.B., page 180.

three nights, is the major source of early information on ballasting and other aspects of early screw colliers, made particularly valuable by the presence in the audience of some of the leading players, including Charles Palmer, John Scott Russell and Croome.

There had clearly been considerable experience with bag water ballast by the time Allen presented his paper, although the developments and variations he describes suggest that problems had not been fully overcome.[78] Allen describes bags made of canvas rendered waterproof with rubber and tar, each holding five to ten tons of water. They were arranged in the bottom of the hold, held in place by bands running from side to side of the vessel and fore and aft. Discharge involved allowing the water to run into the bilges, from where it was pumped out, by hand in sailing colliers or by an auxiliary steam engine in the case of screw colliers. Allen estimates the cost of the bags at £125 for a sailing collier which required about 50 tons of ballast. He provides a plan of three screw colliers fitted with bag ballast *Eagle*, *Falcon* and *Hawk*, which carried almost 100 tons of ballast in bags. Based on the savings in the cost of sand ballast, and avoiding the 40-days per annum delays in loading (the water could be loaded or discharged from the bags whilst the vessel was underway, which would allow the collier to make one additional voyage

77. Allen, E.E., page 329.
78. Allen, E.E., pages 328-333.

each year) he estimates the annual saving at £90, so that the bags and equipment paid for themselves in 18 months. His further claims for the advantages of bag ballast give the feeling of a man clutching at straws. His argument that bag ballast gives a modest collier some 12 tons extra buoyancy over sand ballast, and could thus help prevent her sinking, seems to ignore the fact that equal weights of water and sand would need to be carried. He goes on to claim that the bags could be filled with air to float a vessel off a shore, or even to prevent her foundering, but gives no details of how this would be achieved other than noting vaguely that '... the arrangements necessary...would neither be difficult nor expensive'.

Allen does refer, although almost in passing, to the principal weakness of using bags for ballast, the damage they suffered when a coal cargo was loaded on top of them, usually by being teemed from a considerable height. His estimate is that the bags would last six years in a sailing collier and three years in a screw collier, despite the latter doing three times the work of the former. That wear and tear of the bags was a bigger problem than he would admit is suggested by the developments he mentions in his paper. According to a footnote, bags had recently been devised which could be rolled up when not in use, so saving them from damage. In the screw collier *Northumberland* wooden flaps had been fitted over the bags to protect them. Allen is enthusiastic about these flaps but critical of the way they had been applied, noting sourly that they '...would have answered, if the flaps had been well fitted.' *Northumberland* had been completed in June 1853 by Palmer at Jarrow, and was possibly the first screw collier to be given bag ballast. In view of the pace of development at this time,[79] it seems likely that, in the two years between her completion and Allen's 1855 paper, the wooden flaps would have been improved if shipbuilders and shipowners had considered bag ballast to have the advantages Allen claimed. Scott Russell, who had fitted bag ballast to at least three of his screw colliers, *Eagle* (registered July 1853),[80] *Falcon* (registered December 1853) and *Hawk* (registered February 1854) evidently did not find it the ideal solution as he went on to experiment further with other ballasting arrangements.

The lengthy discussion on Allen's paper reveals that practical experience was firmly against bag ballast, several commentators suggesting that the bags became either worn or damaged much more rapidly than Allen allowed.[81] The bags in the *Northumberland*, despite being protected by wooden flaps, had lasted a mere nine months according to a Mr. Croome, who claimed to have been professionally involved in the construction of 13 or 14 screw colliers (presumably as a designer: he is

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79. Allen's paper was delivered in February 1855, by which time 38 screw colliers had been completed, according to the author's database (see Appendix 2).
80. Registration documents for London in the National Archives, class CUST 130.

certainly not named as a builder or owner on any registration documents examined).[82] Croome is scathing about the dangers posed by worn bags to the ship and its crew, where '...in bad weather, the working and weeping of the bags, had been watched with the most intense anxiety, by those on board, well aware that their lives were, in all probability, literally dependent upon the endurance of a thread.' Despite the initial enthusiasm for bag ballast, experience rapidly told against this method.

A different and ultimately highly successful ballasting arrangement, the double bottom, was adopted for the screw collier *Haggerston*, completed at Liverpool on 25th August 1852.[83] A Government committee on the state of merchant steamers reported that *Haggerston* '...was a very strong built vessel with an inner bottom divided into tanks containing 80 tons of water ballast when her cargo of 600 tons of coal is delivered.'[84] The double bottom was perpetuated, probably in Vernon's *Hunwick* (registered 23rd November 1852), and certainly in his *Black Prince* (completed 11th August 1854), in *Firefly* (completed 1st September1854), and in the River Dee-built *Chester* (completed 9th December 1854).[85]

81. For instance a Mr Fletcher, who had experience of designing iron screw vessels for the iron ore trade. Allen, E.E., pages 349 and 353-355.
82. Allen, E.E., page 350.
83. Registration documents in the National Archives, CUST 130/45.
84. This report is quoted in Macrae, J.A. and Waine, C.V., pages 13-14.
85. Allen, E.E. lists these vessels in one of the plates accompanying his paper. Completion dates are those of the Builder's Certificate, marked on the vessels registration papers held in the National Archives (CUST 130 for London-registered ships, and class BT108 for others).

Allen refers to the double bottom system as 'bottom water ballast'.[86] He enumerates its disadvantages, chief of which is the high first cost, which he estimates as adding £1,200 - probably more than 12 per cent - to the collier's construction cost. Presumably in an attempt to save costs, the inner bottom had been made of wood, but this had proved impossible to keep watertight and the vessels so constructed had been rebuilt with tank ballast. The double bottom did not detract from the cargo capacity of the hold, but it did add up to three feet to the depth of hold. Partly because of the need to keep the double bottom watertight, access was difficult, and this added to maintenance and repair costs.

In the later double-bottom ships, *Black Prince*, *Chester* and *Fire Fly*, the system had been developed to include, as well as water in the double bottom, tanks both under the forecastle and in the stern, giving a total ballast capacity of 160 tons. Allen concedes that the method of construction used in these vessels considerably reduced their first cost compared to the earlier double bottom vessels, and the practical ship designer Croome was prepared to prove that a double bottom added only 5 per cent to initial cost.[87]

Unlike bag ballast, which was severely criticised by Allen's audience, the double bottom received favourable comment from the floor.

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86. Allen, E.E., page 333
87. Croome in the discussion of Allen, E.E., page 353.

Croome volunteered that the system of double bottom tanks with connecting fore and aft tanks 'had not occasioned the slightest difficulty' and felt that it was 'next to impossible...that it could go wrong'.[88] The fore and aft tanks also rendered the ship better in a seaway, as by raising the centre of gravity of its cargo it made the ship's motion more comfortable. The double bottom also added to the strength of the ship, an important consideration in a collier which regularly took the ground. The inner skin provided by the double bottom added to its safety.

Although overshadowed by later developments in ballasting technology, the double bottom certainly survived as a constructional method, as much for its added strength and safety as for its ballasting capabilities (in some motor vessels the space created is used to store fuel), and Liverpool shipbuilder Thomas Vernon along with designers Croome and Grantham deserves credit for contributing to its development.

Following Vernon's *Hunwick*, the next screw collier completed was Scott Russell's *Lady Berriedale*, registered in January 1853. She was intended to do without ballast, Scott Russell reckoning it 'so much dead load, or unprofitable cargo.'[89] *Lady Berriedale* was designed so that the weight of her engines and boiler kept her screw submerged. But this gave a problem, in that to ensure a reasonable freeboard she could not be deeply

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88. Allen, E.E., pages 350-1.
89. Discussion to Allen, E.E., page 362.

loaded.[90] At times - presumably of heavy weather - *Lady Berriedale* did carry conventional ballast in order 'to make her hold the wind better', for all the early screw colliers had extensive sets of sails, but the cost of loading and discharging the ballast was considerable.[91]

Scott Russell learnt lessons from the *Lady Berriedale*, and in his later colliers made provision for ballast. As discussed earlier, *Eagle*, *Falcon* and *Hawk* had bag ballast. In his colliers *Pioneer* and *Imperial*, both completed in 1854, Scott Russell included a central watertight hold which could be filled with water for ballast voyages or with coal when the vessel was laden.[92] According to Allen, the water ballast hold was reasonably cheap to build, adding only £300 to £400 to the cost of the vessel, offered a larger ballast capacity than other methods, 200 to 250 tons, and had the major advantage of not reducing cargo capacity. Maintenance was simple, as there was ready access to the hold, and it was also claimed that placing the ballast and hence the centre of gravity relatively high in the hold made for a better sea boat. Allen was very enthusiastic, believing the water ballast hold to be the best and cheapest ballast system.

In practice, however, the water ballast hold had many disadvantages. When carrying ballast in just this hold, there was

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90. Macrae, J.A. and Waine, C.V., page 15, quoting from Scott Russell 'Treatise on Naval Architecture'.
91. Discussion to Allen, E.E., page 362.

considerable strain on the vessel's structure in heavy weather, and bulkheads and joints leaked so that it was difficult to keep the hold watertight. Discussion on Allen's paper involving Robert Stephenson and others revealed that the division of the vessel's cargo capacity into three was considered objectionable for a coal cargo. It increased loading and unloading time, because having to shoot coal into the hold three times led to greater breakage, and this was aggravated by the need to trim three holds rather than one.[93] The water hold had a small hatch, presumably to help secure and make it watertight, and this too was a disadvantage whilst loading coal. Croome also felt the divided hold made the collier unsuitable for other employment, referring to the recent use of colliers as transports for the Crimean War.[94] Scott Russell was said to be building two other colliers with water ballast holds,[95] but this method of construction seems to have been a blind alley as no further reference to it has been found.

As the first practical screw collier, the *John Bowes* has been much written about, but in spite of numerous claims by various authors there is no hard evidence as to her original arrangements for carrying water ballast, if indeed she had any at all. Only in later years, when water ballast

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92. Allen, E.E., pages 334-335.
93. Fletcher in the discussion on Allen, E.E., page 349, Croome, page 355 and Palmer, page 366.
94. Croome in the discussion on Allen, E.E., page 351.

was commonplace, were details of water ballast capacities declared on registration or survey forms. *John Bowes* was classed by Lloyd's Register, and the survey report immediately before her completion makes no mention of any ballast,[96] but it could simply be that the surveyor had nowhere on his form to record such data. Hence, it is only possible to learn what arrangements were fitted to the early screw colliers from secondary sources, such as Allen's paper. These are contradictory. Hodgson, writing in 1901, describes *John Bowes* as having a 'cellular double bottom'[97] but, as his account of the collier's ownership is at odds with that recorded on the vessel's customs registers,[98] his accuracy cannot be trusted. *John Bowes'* hull may not have had any provision for water ballast, as Waine claims that barrels were placed in her holds and filled with water on leaving the Thames.[99] When arriving in the Tyne these were broken open to drain the water.

The evidence from the shipbuilder Charles Palmer, is vague as to whether *John Bowes* had any water ballast capacity when built, although he makes it clear that several experiments with ballast were conducted

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95. One of Scott Russell's notebooks now held in the Science Museum Library (MS516/2) list his completions, and from these it is possible to tentatively assign to these further hold ballast steamers the names *New Pelton* of 1855 and *Nightingale* of 1856.
96. Lloyd's Register's surveyor's reports survive in the National Maritime Museum.
97. Hodgson, G.B., page 179.
98. *John Bowes* was registered at Newcastle on 24.7.1852 as number 55 of 1852, and re-registered on 1.10.1853 as 59/1853; both registration documents surviving in Tyne and Wear Archives. The re-registration does not, alas, indicate that she was quickly modified or fitted with new arrangements for ballasting but, according to a note appended to the second registration form, that a mistake was made on the 55/1852 registration form.

during her early life. Speaking in February 1855, 30 months after her completion, he reported that four different water ballast arrangements had been tried.[100] If it is assumed that he referred to these in chronological order of their fitting, the first arrangement sounds like a double bottom and is described by Palmer as 'water ballast…the ceiling being made of iron, but [I] found it unserviceable, as it could not be kept tight.' Replacing the iron with timber had the same result. Large tanks in the sides, containing 70 to 80 tons of ballast, were tried, but removed for fear they would strain the ship. Bag ballast was also tried, but rejected. Palmer noted that the steamers he had subsequently built were fitted with large flat iron tanks, running the length of the hold, with spaces beneath to permit painting and repair, and that these had been found efficient. These were the celebrated McIntyre tanks, the invention of John McIntyre, a shipbuilder on the Clyde whom Palmer appointed to manage his yard in May 1852.[101] The tanks containing about 60 tons of water were placed on the ceiling, or floor, of the hold, on either side, and across one or both ends of the hold. A further tank in the forecastle holding about 45 tons of

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99. Macrae, J.A. and Waine, C.V., page 16.
100. Discussion of Allen, E.E., pages 365-366.
101. Palmer's Letter Book, Tyne and Wear Archives 1357/7. McIntyre's appointment letter dated 10th May 1852 mentions to an idea for 'a small tank', presumably the water ballast tank, so McIntyre may well have approached Palmer with the idea. The letter is dated during the construction of *John Bowes*, giving further evidence that she was not originally fitted with water ballast tanks, but also indicating that Palmer was well aware even before the pioneer collier's completion that water ballast was a key issue in the successful design of a steam collier.

water kept the hold tanks full.[102]

According to Craig and to Clark, the McIntyre tanks were first fitted to the *Samuel Laing*, completed by Palmer in November 1854.[103] Clark cites a Lloyd's Register surveyor who reported that 20 years later the original tanks in the *Samuel Laing* still remained serviceable.[104] After *Samuel Laing*, Palmer did not complete another collier until *Normanby* in March 1855, and so in the February 1855 discussion the 'steamers he had subsequently built' included as colliers just the *Samuel Laing* and the still incomplete *Normanby*.

Tank ballast had its critics. Allen's paper dismisses water tanks as being expensive and impractical as they reduced cargo capacity.[105] However, this is not supported in the subsequent discussion, Croome making the point that in a collier the hold was never entirely filled with coal, such that even with the collier deeply laden in fine-weather trim there was still 40 or 50 tons of cargo space available.[106] Loss of cargo capacity was, therefore, not important. The tanks had several important advantages in that they could be built into existing ships. They were easier to repair and cost less than a double bottom. By 1855 a refinement had been

102. Allen, E.E., page 335.
103. Craig, R. *The Ship: Steam Tramps and Cargo Liners 1850-1950* (London, 1980), page 7; Clarke, J.F. *Part 1*, page 135.
104. *Samuel Laing* survived until February 1901, when she sank following a collision, a rather frequent occurrence for ships plying the busy east coast routes. Registration documents, National Archives CUST 130/53.
105. Allen, E.E., pages 335.

introduced whereby the tops of the tanks were inclined inwards, so as to help trim the coal cargo.[107]

There were further developments concerning water ballast arrangements, but by 1855 very satisfactory solutions were available in the form of the double bottom and McIntyre tanks. Together and separately these were to be features of almost all powered bulk-carrying vessels, and this continues a century and a half later.[108]

Thus, within the short period from 1852 to 1855, the long-standing ideal of carrying water ballast efficiently had been achieved. This is undoubtedly the major contribution to naval architecture of the screw collier builders. It has been examined in some depth because of its importance to successful collier design. According to shipbuilders, 'In all probability, the coastal coal trade would have been lost to ship owners had water-ballast steamers not been introduced and developed;' whilst the double bottom was '...an absolute necessity' in the coasting trade, without which coasters 'could not be employed profitably.'[109]

Conclusion

The building in the 1850s of successful steam bulk carriers (or screw colliers, in contemporary parlance) saw the conjunction of four

106. Croome in the discussion of Allen, E.E., page 351.
107. Allen, E.E., page 335.
108. Snaith GR, Buxton IB, The development of the bulk carrier. Proceedings of the Conference on Tanker and Bulk Carrier Terminals, Institution of Civil Engineers, 1969.

technologies: building iron hulls, the screw propeller, steam engines suitable for driving screws, and utilisation of water as ballast. How best to carry water ballast (which had been addressed at least as early as 1842) was finally solved by extensive experiments in the first two or three years after screw collier construction had begun. Of the other three technical factors, iron construction and the steam engine had been progressing slowly for half a century, whilst the screw had been available in a sufficiently effective form since the late 1830s. There was therefore no single technological breakthrough that explains the flowering of steam collier construction in the 1850s.

The sudden development of the screw collier raises a number of questions. Was it, as the documented examples suggest, practically confined to the east coast coal trade, or did the concept quickly spread to other areas where coal and other bulk goods were regularly shipped, especially the Irish Sea? This question is addressed in chapters 4 and 5. Secondly, why was so much effort suddenly put into screw collier development in the early 1850s, when much of the technology had been available for years? This is consided in chapter 11, which focuses on emerging commercial factors of rail competition and demand from industrial users for regular and reliable coal shipments.

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109. Clarke, J.F., page 135.

CHAPTER FOUR: BULK CARRYING STEAMERS ON THE EAST AND WEST COASTS, 1850-1870

As discussed in chapter 3, the genesis of the east coast steam collier in the 1840s and 1850s has been well documented.[1] In contrast, little has been recorded about early bulk carrying steamers in the west coast trades. Craig identifies just nine ore- or coal-carrying steamers trading in the Irish Sea in the 1850s.[2] The port of Cardiff might be expected to have nurtured steam colliers: it began to ship high-grade steam coal in 1830, and shipments increased with the opening of the East Bute Dock in 1839.[3] However, Cardiff owners did not purchase the first bulk-carrying steamers until 1865,[4] and then bought them only in small numbers. Other west coast trades would also be expected to be of sufficient importance to warrant the use of steam: coal from the Mersey and south Scotland to Ireland; ore out of the Cumbrian ports; china clay from Cornwall to the north west, limestone from North Wales to the Mersey and Clyde; salt out of Mersey ports.

Despite the apparent opportunities for using steamships on the west coast, however, published surveys of the coal and other bulk trades into and out of Liverpool, Glasgow, Cumberland and other Irish Sea ports have identified very few steamers

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1. See for instance: Allen, E.E., 'On the comparative cost of transit by steam and sailing colliers, and on the different methods of ballasting.' *Proceedings of the Institute of Civil Engineers* XIV (1854-5), 318-73; Craig, R., 'Aspects of tramp shipping and ownership' in Matthews K. and Panting G. (eds.), *Ships and Shipbuilding in the North Atlantic Region* (St. John's, Newfoundland, 1978) pages 209-30; Macrae, J.A. and Waine, C.V., *The Steam Collier Fleets* (Albrighton, 1990); Palmer, C.M., 'On the construction of iron ships and the progress of iron shipbuilding on the Tyne, Wear and Tees.' *Report of the British Association for the Advancement of Science for 1863* 694-701.
2. Craig, R., 'Aspects of tramp shipping and ownership' in Matthews K. and Panting G. (eds.), *Ships and Shipbuilding in the North Atlantic Region* (St. John's, Newfoundland, 1978), page 210.
3. Jenkins, D., *Shipowners of Cardiff: a Class by Themselves* (Cardiff, 1997), page 1.
4. Macrae, J.A. and Waine, C.V., *The Steam Collier Fleets* (Albrighton, 1990), page 67; Jenkins, J.G. and Jenkins, D., *Cardiff Shipowners* (Cardiff, 1986), page 8.

involved prior to the late 1870s.[5] The author has examined customs registers for Welsh and Mersey ports and found that the first steamers which can be classified by their ownership or trading pattern as bulk carriers are the *Thursby* and *Tolfaen* both of 1877.[6] After the late 1870s, growth in the number of bulk-carrying steamers was rapid, with expansion of the Glasgow-owned fleets of William Robertson and the Hay family,[7] and in Liverpool the Mack family and Richard Hughes.[8]

It is therefore hypothesised that steamers did not make a significant impact in the west coast bulk trades for some 25 years after they had begun to be established in east coast bulk trades. This chapter records the work done to test this hypothesis.

Sources and methods

The hypothesis was tested by quantifying the steam vessels designed for bulk carrying which were owned in east and west coast ports and involved in bulk trades on these coasts during the period from 1850 to the 1870s. The major source was a database of steamers compiled from Parliamentary Returns. Identifying vessels engaged in the bulk trades is not straightforward, and the methods used, which are probably novel, are described in detail below.

Identifying candidate vessels

The ships most suitable for the bulk trades were iron-hulled, screw-driven vessels. The stresses induced by steam machinery meant that iron hulls were preferred to wood, and wooden steamers remained rare in the coastal bulk trades although they

5. Macrae, J.A. and Waine, C.V.; Waine, C.V. and Fenton, R.S., *Steam Coasters and Short Sea Traders* (3rd ed. Albrighton, 1994).
6. Fenton, R.S., *Cambrian Coasters* (Kendal, 1989); Fenton, R.S., *Mersey Rovers* (Gravesend, 1997).
7. Waine, C.V. and Fenton, R.S., page 160 et seq.
8. Fenton, R.S., *Mersey Rovers* (Gravesend, 1997), pages 84 and 138, et seq.

continued to be built in small numbers up to at least the First World War.[9] Screw propulsion was proven by the *Archimedes* of 1839, and offered advantages over paddles because it meant the engines could be placed aft, leaving free the part of the hull which was most voluminous and therefore most useful for cargo carrying. With paddles, the engines had to be placed amidships and high up in the hull.[10] In addition, paddles were not suited to the variations in draft consequent upon the need of a bulk carrier to sail in both loaded and unloaded condition.

Iron-hulled, screw steamers were identified from Parliamentary papers listing steam vessels owned in the United Kingdom and dated 1838, 1845, 1849, 1851-2, 1854-5, and 1857-1870. Those of most interest for this study were the *Returns of Registered Steam Vessels of UK* compiled annually from 1851 to 1870, except for the years 1853 and 1856.[11] They give certain details of the steamers listed, including date of build, dimensions, whether paddle or screw and wood or iron, horsepower, port of registry and name of managing owners.

An experienced researcher and author, Mr. Phillip Thomas of Glasgow,[12] has compiled a database listing steamers included in the Parliamentary papers, and he very kindly provided the author of this thesis with a copy. The database was validated by checking it against copies of printed returns for the years 1860, 1869 and 1870. For

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9. Mitchell, W.H. and Sawyer, L.A., *British Standard Ships of World War* (Liverpool, 1968); Carter, S. and Richards, P., 'The loss of the Capitaine Remy', *Ships in Focus Record 8*, 1999 (February), pages 204-210.
10. Bruce, J.G., 'The contribution of cross-channel and coastal vessels to developments in marine practice.' *Journal of Transport History* IV No.2, (1959) 65-80. Reprinted in Armstrong, J. (ed.), *Coastal and Short Sea Shipping* (Aldershot,1996) page 6.
11. The *Returns of Registered Steam Vessels of UK* are in the following Parliamentary Papers:
Jan. 1851 **1851** (196) (310) L.II229, 235; Jan. 1852 **1852** (219) XLIX.35; Jan. 1852-54 **1854** (141) LX.219; Jan. 1855 **1854-55** (473) XI.VI.293; Jan. 1857 **1857** Session 2 (87) XXXIX.61; Jan. 1858 **1857-58** (488) L.II.8; Jan. 1859 **1859** Session 2 (26) XXVII.493; Jan. 1860 **1860** (449) LX.445; Jan. 1861 **1861** (371) LVIII.275; Jan. 1862 **1862** (319) LIV.783; Jan. 1863 **1863** (348) LXIII.99; Jan. 1864 **1864** (371) LV.227; Jan. 1865 **1865** (422) L.361; Jan. 1866 **1866** (381) LXV.419; Jan. 1867 **1867** (446) LXIII.35; Jan. 1868 **1867-68** (429) LXIII.23; Jan. 1869 **1868-69** (360) LV.25; Jan. 1870 **1870** (339) LX.25.

each year, entries for 20 iron screw steamers selected at random from throughout the return were compared and all entries in the database were found to be correct, apart from one obvious typographical error. Indeed, the database proved more accurate than the Parliamentary papers, as a number of mistakes were apparent in the 1869 Returns, including misspellings and errors in dimensions.

Filtering for size

To arrive at a list of vessels suitable for the coastal bulk trades, iron screw vessels were initially selected, and these were filtered for size. Length rather than tonnage was used as a parameter for classifying coasters and colliers. Length was often the crucial factor in deciding where a coastal ship could trade, as locks into docks and canals used by these craft provided a physical constraint. For example, the Camden Lock entrance to the Grand Canal Dock, Dublin for many years limited the size of vessels employed in the UK to Dublin coal trade to 142 feet.[13] Both the Forth and Clyde Canal (66 feet locks) and the Crinan Canal (88 feet locks) constrained the size of small bulk-carrying steamers in Scottish waters (Clyde 'puffers').[14] A further reason for preferring length to gross or net tonnage is that tonnages frequently altered during a ship's career. Reasons for this included minor modifications or a periodic survey, as it was in the owner's interests to minimise the figure for net tonnage, on which port and light dues were paid.[15] Regulations governing the measurement of tonnage were also amended from time to time. On 1st January 1914, gross and net

12. His books include Thomas, P.N., *British Ocean Tramps* (Albrighton, 1992)
13. O'Conalláin, T. 'Dublin Gas Boats' *Ships in Focus Record 7* 1998; Waine, C.V. and Fenton, R.S., page 79.
14. Waine, C.V. and Fenton, R.S., chapter 5.
15. Waine, C.V. and Fenton, R.S., page 17.

tonnages of every British-registered ship were arbitrarily altered, often being amended again later that month as the ships were measured according to the new regulations.[16]

To determine the size window for identifying bulk carriers, a pilot survey of steamers known to be in the coal trade was carried out. This involved selecting ships from the Parliamentary Return data base which had the word 'Collier' as part of the managing owner's title, giving 36 ships. To this were added a further 18 vessels identified as early colliers by other published works.[17] With two exceptions (*Collier*, 95.0 feet but lengthened in 1857, and *J.E. McConnell*, 201.3 feet), all these fell in the size range 100 to 180 feet. The upper limit was therefore established at 180 feet, and - as a number of smaller steamers were registered in west coast ports - it was decided to use a lower limit of 80 feet, with the possibility that ships in the range 80 to 100 feet would later be excluded if evidence showed that they were predominantly employed in sheltered waters rather than making coastal or short sea voyages. As work progressed, however, it became apparent that east coast colliers of 200 feet were not as unusual as the pilot study indicated, possibly because vessels were being built which were suitable for the Baltic and Mediterranean trades as well as the coastal trades. It was therefore decided to include vessels up to, and in some cases slightly over, 200 feet.

Filtering by ownership

As iron screw steamers were employed in other than UK coastal bulk trades, including liner services, and longer-distance trades (e.g. Mediterranean, Baltic), it was necessary to establish which vessels were employed in bulk trades. Neither the vessels' official registration documents nor entries in classification society registers such as *Lloyd's*

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16. National Archives class BT110

Register indicate the vessel's type. Initial filtering was therefore done on the basis of the name of the vessel's managing owners. A ship was excluded if the company title clearly indicated such a trade (for instance, *Amazon* of the Peninsular and North African Steam Navigation Company) or its owner was known to be involved in such trades (e.g. *Agnes Jack* of John Bacon, who operated services from Liverpool to the Bristol Channel and whose fleet was later to be one of the initial constituents of Coast Lines Ltd.[18] In contrast, presumptive evidence that the ship was intended as a bulk carrier was involvement of the owners in some aspect of a bulk trade, including colliery and quarry owners, coal factors and merchants (e.g. *Velocity* owned by the East of England Screw Collier Co.).

It could be argued that the process of filtering on the basis of the predominant trade of the owner has the weakness that an owner associated with a regular liner trade could place its ship in a bulk trade if such employment offered a favourable return, whilst an owner who concentrated on the bulk trade could charter his ship for use in a regular trade. There is little evidence that ships built as colliers moved permanently to other trades. Charles Palmer, a partner in the Jarrow shipbuilders Palmer Brothers and Co. Ltd., lamented that ships specifically designed for the coal trade were being taken out of it and transferred to liner trade companies.[19] He is probably referring to the *Marley Hill* and *Northumberland*, two steamers his yard built which in 1863 were sold by the General Iron Screw Collier Co. Ltd. to Frederick H. Powell, who operated liner

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17. Craig, R., *The Ship: Steam Tramps and Cargo Liners 1850-1950* (London, 1980); Macrae, J.A. and Waine, C.V.,; Jenkins, J.G. and Jenkins, D., *Cardiff Shipowners* (Cardiff, 1986)
18. Chandler, G., *Liverpool Shipping: a Short History* (London, 1960) page 53
19. Palmer, C.M. 'On the construction of iron ships and the progress of iron shipbuilding on the Tyne, Wear and Tees.' *Report of the British Association for the Advancement of Science for 1863*, pages 694-701.

services between Liverpool and Bristol.[20] However, no other examples have been found of a collier passing to a known liner trade company.

It is unlikely that an owner involved in the liner trade would build a steamer for the bulk trades, or that an owner in the bulk trade would build one intended to be a liner. The two types of owners' building intentions would, presumably, reflect opportunities in their respective trades, and so it seems valid to classify steamers as being intended for the liner trade or for the bulk trade.

Other preliminary filters

Other filters have been employed. For vessels listed in *Lloyd's Register*, a 'destined voyage' was shown (this entry last appears in the 1873 edition). This information was recorded by the Lloyd's Register surveyor when reporting on the completion of a ship built under the society's classification, and was presumably obtained in conversation with the vessel's master. The destined voyage needs to be treated with caution, as the details are rarely altered from year to year. For instance, the destined voyage of the Isle of Man-built *Bintang* of 1864 is listed as 'IM [Isle of Man] to China' in *Lloyd's Register* right from 1865 through to 1873. Nevertheless, as in the case of the *Bintang*, such information is often sufficient to exclude the possibility that an iron, screw steamer of the appropriate size was intended for working in the UK coastal bulk trade.

The yard that built the ship gave a further indication of its intended role. Some builders, including Palmers of Jarrow and Howden, Laings on the Wear, Scott Russell on the Thames, specialised in building colliers, devoting much effort to refining their

20. Chandler, G., *Liverpool Shipping: a Short History* (London, 1960), page 51.

designs. Owners wishing to have bulk carriers built would tend to turn first to yards with an established reputation for building this class of vessel.

Crew agreements

When a vessel's employment was not clear from ownership details, crew agreements were inspected. These recorded the ships intended voyage. For ships in the home trade, six-monthly returns were made listing the crew members who served during this period and briefly indicating the voyages made. The voyage descriptions varied from the terse ('Coasting between England, Scotland and Ireland' reported the master of the steamer *Preston* in 1855) to detailed lists of voyages with dates of departure and arrival. Fortunately, the masters in the east coast coal trade seemed punctilious in recording their vessel's individual voyages. They also frequently added 'In the coal trade', whereas other masters did not give any indication of their cargo (indeed, they were not required to do so). Masters of foreign-going ships were often vague in their description of the voyage, sometimes merely referring to 'Gibraltar and ports in the Mediterranean', whilst in some agreements for foreign trade vessels all that is recorded is the departure and arrival dates at UK ports. On some foreign voyages a member of the crew was discharged, deserted, or died, or a replacement signed on at a foreign port, and this was recorded in the list of crew with the date and name of the port.

Because details of cargo are omitted from most crew agreements, some interpretation of the data is necessary. Many of the ships in the size range targeted which were registered in Liverpool or Glasgow were making voyages from their home ports to France, Belgium, Spain, Portugal, the Mediterranean and (to a lesser extent) the Baltic. In the 1850s and 1860s, Liverpool and Glasgow were not major coal-exporting ports, and the length of these voyages, with calls at several foreign ports, suggests a liner-type, general cargo trade, rather than a bulk trade. Home trade voyages are more difficult to classify, but a liner-trade service was indicated by regular calls at a number of ports during an individual voyage. For instance, in 1856 the Liverpool-registered *Loire* was making fortnightly voyages from Liverpool to London with calls at Penzance and Falmouth. A regular schedule and unvarying route also distinguishes liner traders: in 1857, for instance, the *Stockton* was making one voyage exactly every seven days from Stockton to London. In contrast, many steamers in the coal trade on the east coast varied their voyage patterns. In the second half of 1857, for instance, the steam collier *Black Boy* made three voyages from Hartlepool to London and back to Hartlepool, and twenty from Sunderland to London and back to Sunderland. The voyages in the bulk trades were less regular, probably reflecting delays at loading or discharging berths.

The availability of crew agreements in the UK is patchy. All agreements up to 1860 are, in theory, available in the National Archives. For the years 1861 onwards, the National Archives took a random 10 per cent sample, some local record offices in the UK took agreements of interest to them, and the National Maritime Museum took the remainder for 1861 and 1862 and thereafter for every year ending in '5'. The others for 1863, 1864, and 1866 onward - about 70 per cent of the total - are in the Memorial University of Newfoundland.

Even for crew agreements theoretically held in the UK, there are gaps for certain ships known to have been registered in the period up to 1865. It may simply be that the masters never filled in or returned the agreements, or that shipping masters in the ports failed in their duty to demand and forward agreements. However, the records for east coast colliers are reasonably complete, suggesting that shipping masters were more punctilious in insisting on documentation from ships that came in and out of their ports regularly. The cases of the Glasgow-owned and registered *Black Swan* of 1853 and *White Swan* of 1854 shows what may have happened to other crew agreements. For these ships crew agreements are found only for the first voyages, which were from the Clyde to Australia where they were to be used in the coastal trade, and possibly sold. Despite these ships remaining registered at Glasgow for a number of years, crew agreements for subsequent years have not been found; presumably they were never sent from Australia.

Despite the limitations discussed above, crew agreements are a very valuable source of data on a vessel's occupation, and UK sources were searched to find at least one agreement for each of the vessels whose involvement in bulk trades could not be excluded for reasons given earlier. In addition, agreements for ships identified as colliers and bulk carriers were also checked to confirm their trading status and, in particular, whether they were trading coastwise or making foreign voyages.

Reports of shipping movements in newspapers

After 1865 crew agreements become an impractical source for the UK-based researcher, as all but about 20 per cent are housed in Newfoundland. For details of movements which may help to classify a vessel as bulk or liner trade for this period, a search was made in the daily shipping newspaper *Lloyd's Lists*.

Searching was made practicable by an index to the entries, compiled in manuscript form by Lloyds of London. Microfilm copies of this index are in the custody of the Guildhall Library, London. The entries in the index were intended as a guide to finding entries in the newspaper itself, but for the period under consideration the port at which the vessel was reported is recorded, as an abbreviation. The handwriting and subsequent microfilming of theses indexes means that the abbreviations are sometimes indecipherable. A further difficulty is that, although steamers are distinguished from sailing vessels, ships of the same name are distinguished only by the name of the master, making it difficult to be certain that the correct vessel was being followed when they have common names such as *Victoria* or *Queen*. Nevertheless, the index entries can show at a glance where many ships traded in a given year. The search for shipping movements in these indexes was extended to ships which did not show up in crew agreements for the period prior to 1865.

The *Lloyd's Lists* indexes for the late 1860s proved useful for eliminating vessels from the list of possible bulk carrying steamers, but a substantial proportion - perhaps a third - of the ships searched for were not listed or could not be identified with certainty. Only in a few cases could the missing ship be found by extending the search forward or backward over the period when the ship was registered in British ownership.

It needs to be asked why are some vessels not recorded in *Lloyd's Lists*. Some of the unlisted vessels may not be trading, or even in existence, even though their UK registers are still open. A ship's register was sometimes not closed for several years after it was lost. The collier *Hawk*, for instance, was lost in November 1862, but its registration was not closed until August 1864. Cottrell cites an even more extreme example; the Liverpool-registered steamer *Manchester* of 1825 was still on the port's register in 1870 despite being declared 'worn out' when surveyed 25 years before.[21] For vessels trading far from home waters, delays in closing registrations would be even more likely. Nevertheless, absence from *Lloyd's Lists* cannot be taken as evidence of non-existence. Vessels in minor ports were not reported in *Lloyd's Lists*. There seems to have been a bias to reporting only those vessels involved in foreign trades, and perhaps to ignore those that appear very regularly in a given port, such as east coast colliers. For instance, there is only one entry for the collier *John Bowes* for the whole of 1867. It is also likely that ships trading locally, say within the Firth of Clyde or the Mersey estuary, were not reported even when in major ports such as Liverpool or Glasgow. For these reasons it was unsafe to ignore vessels which cannot be found in *Lloyds Lists*.

To address the problem of omission from *Lloyd's Lists*, a search was made of entries in a rival publication, the *Shipping and Mercantile Gazette.* There is no index to this newspaper, which makes searching a matter of looking down the columns for each UK port to find movements of targeted vessels. Steam vessels were, usually, designated by the letters 's' or 'ss' alongside the name. The *Shipping and Mercantile Gazette* gives better coverage of small UK ports than does *Lloyd's Lists*, and listings extend to such minor harbours as Aberayron, Appledore and Bridgwater, a significant proportion of whose trade was coastwise. This means that - although laborious –

21. Cottrell, P.L., 'The steamship on the Mersey, 1815-80: investment and ownership' in Cottrell, P.L. and Aldcroft D.H. (eds.), *Shipping, Trade and Commerce: Essays in memory of Ralph Davis* (Leicester, 1981), page 140.

searching its columns will indicate whether vessels not found elsewhere were indeed trading on the coast. For instance, the Glasgow-registered *Carradale*, which at 80 feet is at the lower limit of vessels recognised as coastal traders, is listed in the *Shipping and Mercantile Gazette* for 1st January 1868 as trading between Leith and Alloa. She has been found neither in the index to *Lloyd's Lists* nor in the crew agreements, probably because, until she was lengthened in 1866, she may have been confined to sheltered waters such as the lower Clyde. Conversely, absence of a vessel from the crew agreements, *Lloyd's Lists* and the *Shipping and Mercantile Gazette* indicates that the vessel was most unlikely to be trading on the UK coast, and such vessels can be discounted from further consideration.

Registration documents (BT108)

For west coast-registered vessels whose trade could not be identified from other sources the registration documents held in the Public Record Office as class BT108 were examined. In some cases, registration data suggested that the ship never traded in UK waters. For instance, the Swansea-registered *Firefly* of 1849 was sold in Valparaiso in 1854, and a likely explanation of the complete lack of crew agreements for this ship is that she traded on the Chilean coast for the copper merchants who owned her. The registration documents also record changes of master, and the port at which the change took place, giving an insight into trading patterns. For instance, between 1864 and 1895 the tiny *Isca* changed masters twice in her home port of Newport and three times in Bristol, suggesting she was confined to trading in the Bristol Channel. The BT108 documents have therefore allowed the elimination from the lists of vessels which were clearly not bulk carrying on the west coast of the UK.

Data and histories for bulk carrying steamers

To estimate the number and tonnage of steamers in the various bulk trades, it was necessary to know how long each traded, and to assist in this histories were compiled of each steamer identified as in the east or west coast bulk trades up to about 1880, detailing changes of owners, registration, tonnages and fate. Information was taken from the Parliamentary Returns of Steamships, the *Mercantile Navy Lists*, *Lloyd's Registers,* the *Liverpool Underwriters Registers of Iron Ships,* the *Closed Registers* in classes BT108 and BT110 in the National Archives, registration papers for Newcastle-upon-Tyne in Tyne and Wear Archives and, to date any casualties, *Lloyd's Lists* and other sources of casualty data. This data is presented as Appendix 2.

Numbers and tonnages of west and east coast bulk carrying steamers 1850-1870

Using the methods discussed above, a list has been compiled showing the total numbers and total net register tonnages of bulk carrying steamers working during each year between 1850 and 1870, table A.1 for the west coast and table A.2 for the east coast (tables A.1 to A.7 and figures A.1 to A.3 are presented in Appendix 1). Figures for net tonnages of some ships in the tables fluctuate from year to year, as a result of the ship being lengthened, being re-measured, or being modified to minimise its tonnage. As harbour and other dues were paid on net tonnage, it was in the owner's or operator's interests to make the tonnage figure as small as possible.

Expressing the figures graphically (figures A.1 and A.2), it is apparent that the numbers and the total tonnages of bulk carrying steamers working on the east coast completely overshadow those on the west coast for every year from 1850 to 1870. Two time points can be singled out. In 1855, the east coast collier fleet was expanding with 2000), reflecting that the east coast bulker was on average almost twice as large. During the period under review west coast steam bulk carriers reached their peak in terms of tonnage in 1867, at a time when the growth in the tonnage of east coast colliers had slowed. But even in this year, the number of east coast colliers at 132 was three times that of west coast bulk carriers at 40 units, and the disparity in total net tonnages was sevenfold, 63,000 tons versus 9,000. In 1867 the east coast collier was, on average, well over twice as large in net tonnage terms as the west coast bulk carrier (473 compared 225 net tons).

Allowing for 'unassignable' steamers

A number of the steamers listed in Parliamentary Returns defy assignment to trades because no record of them can be found in Crew Agreements, or in contemporary editions of *Lloyd's Register*, *Lloyd's Lists* or the *Shipping and Mercantile Gazette.* The most likely explanation is that these vessels were simply not trading on the British coast.

The smaller vessels may have been confined to inland waterways (such as the canal and river systems around the Mersey, Severn or Clyde). Another reason is that steamers were sometimes registered in the nearest port to which they were built as a preliminary to sailing to some other part of the world where they were employed. Numerous such examples have been found from examination of crew agreements. For instance, the *Seigmund Robinow* was registered at Glasgow on 15th March 1856, and the only surviving crew agreement records that she left on 21st April 1856 for Stettin, where she was sold. Notwithstanding this sale, she is still listed in the 1857 Parliamentary Return as a British vessel, remaining on the Glasgow registry. The *Express* was registered in London on 11th January 1854, and her first (and only

21st April 1856 for Stettin, where she was sold. Notwithstanding this sale, she is still listed in the 1857 Parliamentary Return as a British vessel, remaining on the Glasgow registry. The *Express* was registered in London on 11th January 1854, and her first (and only surviving) crew agreement records her leaving under sail for Melbourne where, presumably, she was to be employed as a steamer in the coastal trade. Nevertheless, *Express* is recorded in the Parliamentary Returns as London-registered until 1858. It is likely that the other vessels which cannot be assigned had similar adventures: in almost all cases, they remained registered in a UK port for only one or two years, which suggests that they soon were registered where they were serving.

The total of 'unassigned' vessels is 85. Although this represents less than 10 per cent of the known iron screw steamers in the chosen size band for the period 1849 to 1870, it is a relatively large total compared with the small numbers of steamships positively identified as trading on the west coast. The question needs to be asked: if these vessels were all trading on the west coast, and if by some freak their masters had all failed to file crew agreements and the vessels were ignored by agents of both *Lloyd's Lists* and *Shipping and Mercantile Gazette*, would this distort the findings in tables 1 and 2 that show a preponderance of steam on the east coast? To answer this, the 24 undefined, west coast-registered vessels have been listed (table A.3). The vessels registered in London and east coast ports are ignored as being unlikely to work on the west coast: with few exceptions all the west coast bulk traders positively identified have been registered in west coast ports. The numbers and net tonnages of 'assigned' and 'unassigned' west coast steamers from tables A.1 and A.3 have been summed for each year, and the figures for 'assigned plus unassigned' vessels compared with the east coast and 'assigned' west coast figures to produce figure A.3.

From figure A.3 it is apparent that the addition of 24 'unassigneds' makes very little difference to the dominance of east over west coast bulk carriers for every year. Taking the same years as above, their addition makes no difference to the ratio of east to west coast bulk tonnage in 1855, and reduces the 1867 ratio from 7 to 1 to 6 to 1. These are worst possible cases, as it can be argued that the 'undefined' steamers registered elsewhere than on the west coast may well include some working as east coast colliers, which would push the disparity even further towards the east coast colliers.

These figures strongly support the hypothesis that, during the period 1850 to 1870, steam made a much greater penetration of the coastal bulk trades on the east coast of Britain than on the west coast.

Employment of east coast colliers

The east coast colliers listed in table A.2 were all, at some point, loading coal on the Tyne, the Wear, at the Hartlepools, on the Tees, or at Goole, and steaming south to deliver it, almost invariably, on the Thames, although some east and south coast ports occasionally received cargoes from steam colliers. East coast-based steam colliers also carried coastwise cargoes of coal from Cardiff to the Thames and to Southampton. For instance, crew agreements show that the *Earsdon* of 1855, whose owners were from both London and Sunderland, was running from

Cardiff to Southampton and London in November and December 1856.[22] There were only a few colliers taking cargoes northwards to Scottish ports; for instance, the *Curfew*, built at Dundee in 1867, was said to be intended for the coal trade between Dundee and Sunderland,[23] whilst the *Scotia* of 1866 was running between Newcastle and Grangemouth in 1867.[24]

Colliers working outside the coal trade

Voyage details in crew agreements between 1851 and 1860 make it abundantly clear that vessels identified as colliers were not consistently employed in the east coast coal trade. Voyage patterns vary, not only from ship to ship, but also both from year to year and season to season for the same ship.

One extreme was shown by the *Countess of Durham,* whose registered owner was Henry Morton, agent for the Earl of Durham who owned the Lambton Collieries around Hetton in County Durham. In 1860 *Countess of Durham* was exclusively employed between Sunderland and London, making 40 round voyages. In contrast, during 1858 the Earl of Durham's *Lambton* made three return voyages between Sunderland to London, but also four voyages from Sunderland to Havre, four to Dieppe and one to Ostend.

There is also evidence that colliers were making much longer voyages, with a pattern of calls at ports which suggest that at least one part of the voyage was in the liner trade. An example is the *Chester*, owned by the General Screw Collier Co. Ltd., a company whose title was unambiguous about its intentions. From October 1856 to January 1857, *Chester* made ten round voyages from the Tyne to London, almost

22. National Archives BT98/4580

certainly carrying coal (in this instance the crew agreement described the voyages but not the trade). In June 1857 *Chester* began a foreign trade voyage of two months' duration, beginning and ending in London. The only clue to which ports were visited was the discharge of a crew member at Cork. The *Chester's* crew agreements for 1859 make her pattern of trading slightly clearer, although the articles which the crew signed cover trading over an exceedingly wide area, from the Black Sea, the Mediterranean, Portugal, Spain, France, Norway to the Baltic. Particularly well documented was a voyage that began in London on 14th June 1859 and ended there on 14th August 1859. Consular stamps (the consul was required to confirm that a crew member was discharged or signed on to the ship's articles) show that during this voyage *Chester* called at Genoa, Leghorn (Livorno), Naples, Messina, Palermo and Massala. Quite likely she called at other ports. Other voyages to the Mediterranean beginning in London during 1859 included a call at Cardiff outbound, suggesting that a cargo of coal was being loaded for the Mediterranean. The number of ports of call, and what was presumably a final discharge in London, suggest strongly that *Chester* was returning from Italy with some form of general cargo, and possibly fruit. To complicate matters even further, during this year *Chester* made at least one voyage beginning at London, calling at Newport, and thence to Danzig before returning to the UK.

Chester was by no means an isolated example of a collier working outside the coal trade. In October 1860, when the onset of autumn would suggest that the collier trade would be buoyant, the General Screw Collier Co. Ltd. was sending its *Derwent*

23. *Mitchell's Steam-Shipping Journal* 1867

from London to the Canaries, and in June 1865 she was wrecked off South Uist whilst bound from Danzig to London with wheat. In 1853 the same company's *William Hutt* took time off from the Tyne to London coal trade to lay two telegraph cables, one from Dover to Ostend and the other from Donaghadee to Port Patrick. Notwithstanding the company's title, the General Screw Collier Co. Ltd. was clearly putting its ships into whatever trade seemed to offer the best chance of profit.

As large-scale diversions from purely coastal trades (the Tyne, Wear, Hartlepool, West Hartlepool and Cardiff to London) affect the comparison made above between steam bulk carriers on the east and west coasts, the trading pattern of screw colliers in the period up to 1860 has been analysed using crew agreements, which are readily accessible for this period.

Analysis of collier trading patterns

In 1855 and 1856 colliers figured prominently amongst the vessels chartered by the Government to supply the British Army during the Crimean War. A Parliamentary Paper[25] lists some 35 colliers which were taken up as Crimean War transports, a high proportion of the total of 47 in service during 1855 and 1856. In addition, the French Government also took up some British vessels, probably including colliers. The service of these colliers as transports completely distorted the trading pattern of the collier fleet for these years, and so 1855 and 1856 have not been included in the analysis of collier trading patterns.

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24. *Shipping and Mercantile Gazette* 1st January 1867.
25. *Return Relating to the Ships engaged as Regular Transports, between the 1st of January 1855 and the 1st of April 1856.* **1856** (345) XLI.341

For the years 1851 to 1854 and 1857 to 1860, crew agreements covering 41 different steam colliers for a total of 53 'collier years' have been examined (table 4.1). For each year the percentage of time each collier spent in the coastal trade has been estimated, and this percentage has been summed and divided by the number of 'collier years'. This calculation shows that steamers built for east coast owners as colliers were running in the coastal coal trade for 59 per cent of the time. For the remaining time they were trading from coal ports to France and Belgium, and making longer voyages from London and the coal ports to the Baltic, the Iberian Peninsula, and the Mediterranean, during which they were clearly not exclusively engaged in carrying coal.

Adjustment of east coast tonnage

The finding that an east coast collier was, on average, an east coast collier for only 59 per cent of its life affects the comparison of east and west coast trades made above. However, even if it is assumed that the west coast bulk trader remained true to its coastal routes and was not tempted into liner and more distant trades (and evidence below challenges this assumption), the preponderance of east coast tonnage is so great that even reducing it to 59 per cent of that estimated still gives ratios in favour of east coast net tonnages of 6 to 1 for 1855, and 4 to 1 for 1867.

Steamers in the iron ore trade

The steamer dedicated to ore carrying appears to have emerged as a distinct type of vessel, albeit in small numbers, soon after the development of the collier. The discussion of Allen's 1855 paper on colliers[26] makes reference to four ships being built in 1854 for the iron ore trade, specifically the *Anne* (built for use in South America), *Arthur Gordon*, *Auguste Louise* (which seems to have entered the general cargo trade) and *Iron Age* of 1854 (used in the west coast trade). All carried bag ballast, whilst *Arthur Gordon* and *Iron Age* also had water ballast tanks. The latter were designed to meet the special requirements of carrying iron ore. As a high-density cargo, iron ore needed to be loaded relatively high in the vessel, raising the centre of gravity so that the vessel would not be too 'stiff' in a seaway, and would roll with a motion which was comfortable for those on board. Further, the water ballast tanks helped give the fore and aft strength needed with such a heavy cargo, especially in vessels which regularly took the ground to load and discharge. The third desirable feature of an ore-carrying vessel which Allan listed could be applied to most vessels: a minimum net tonnage on which harbour dues were paid.

Table A.4 lists east coast steamers identified as working in the iron ore trade. The figures indicate that far fewer steamers were built as ore carriers than as colliers, and that ore carriers remained small in terms of their average net tonnage. Interpreting the data here requires some caution, as ore carriers seem to have at times carried general cargo (possibly manufactured iron) and, conversely, colliers seem to have occasionally carried iron ore (see below). However, the pattern emerging seems very different to that of the rapidly-expanding fleet of steam colliers which were continually growing in size, and the east coast iron ore carriers

26. Allen, E.E., 'On the Comparative Cost of Transit by Steam and Sailing Colliers, and on the Different

have more in common in size, numbers and growth rates with west coast bulk carriers (see next section).

Palmers, who built the pioneering collier *John Bowes*, used steamers to move ironstone from their quarries in North Yorkshire to the iron works which was an integral part of their shipyard at Jarrow. Palmers built a number of small steamers for this trade, including the *Rosedale* of 1855, the *Mulgrave* of 1863 and the *Grinkle* of 1867.[27] But they also used their steam colliers, including the *Normanby* of 1855, which made four voyages from the Tyne to Yorkshire between voyages in the coal trade in 1857,[28] and the *John Bowes* which was recorded in January 1863 as visiting 'Rosedale' (she loaded at Port Mulgrave, which received its ironstone by railway from mines in the valley of Rosedale).

According to crew agreements and shipping newspapers, routes for the other ore carriers centred on Middlesbrough, Stockton and the Hartlepools, and it is hard to discern a pattern in this trade, which involved voyages to and from Grangemouth, Newcastle, Hull, London, Rotterdam, Antwerp, France and Baltic ports. In the absence of a clear trading pattern as found with east coast colliers, identification of putative ore carriers has relied heavily on occasional mentions in *Mitchell's Steam-Shipping Journal* and their ownership by ironmasters such as H.F.W. Bolckow, John Vaughan, and Henry W. Schneider, and it is quite possible

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Methods of Ballasting.' *Proceedings of the Institute of Civil Engineers* XIV (1854-5), pages 318-373.
27. Unpublished database of Returns of Registered Steam Vessels of UK, compiled by P.N. Thomas.
28. National Archives BT98/4927.

that these men were running their vessels on liner voyages which carried, at least in part, their products.[29]

Employment of bulk-carrying steamers on the west coast

The trading pattern of bulk carrying steamers on the west coast in the period 1850 to 1870 appears to be more fragmented than that of east coast screw colliers. Trade in iron ore was initially at least as important as that in coal, and indeed several early steamers carried both commodities, typically ore from Cumberland and North Lancashire to South Wales, then steam coal back to Liverpool. There were also local trades, across the Bristol Channel with coal and ore, from North Wales to the Mersey with stone and ore, and around the Clyde.

The total number of vessels is small, and intimate details of their trading patterns are not known with any certainty: the crew agreements which are available cover a six month period and nominate a trading area but are usual non-commital about cargoes and specific voyages. Given these uncertainties, conclusions must be drawn with caution about the relative importance of west coast trades for bulk carriers, the size of vessel used, and the ports and cargoes involved.

The first important trade for west coast bulk carriers was iron ore, shipped from Cumberland to South Wales. A factor may have been the availability of back cargoes of coal from South Wales to Liverpool, where it would be used in preference to local coal because of its superior steam-raising properties. However,

29. The 1858 crew agreements for Bolckow and Vaughan's *Iron Master* show that she made 16 voyages between Middlesbrough and London between January and May and that she carried two stewards, indicating that she catered for passengers (National Archives BT98/5274). However, throughout the remainder of 1858, and during 1859 (National Archives BT98/5895) and 1860 (National Archives BT98/6578) she made a series of voyages with no discernible pattern from UK ports including Middlesbrough, London, Dundee, Cardiff, Liverpool and

from the late-1850s a relative decline set in and the iron ore trade became less important. Vessels identified in the iron ore trade are listed in table A.5, which includes some steamers also identified as carrying coal at times. From table A.5 and table A.1 it is apparent that in 1857 65% of west coast steam bulk carrier tonnage was involved in carrying iron ore, but by 1870 this had declined to 36%. Iron ore was loaded at Barrow-in-Furness and, to a lesser extent, Whitehaven, and shipped to Cardiff, Neath, Newport and Briton Ferry. In addition to the back cargoes of coal to Liverpool and in some cases to Belfast, ships in the Cumberland to South Wales trade made some voyages with no prospect of a return cargo of ore, for instance the *Annie Vernon* made two voyages from South Wales coal ports to Southampton during 1860.[30] On average the iron ore trader had a slightly larger net tonnage than the average for west coast bulk trades overall, for instance in 1857 243 net tons compared with 229 net, but still much smaller than the typical east coast collier.

Table A.6 lists the bulk carriers known to be engaged in carrying coal from east to west across the Irish Sea, a list which includes some steamers involved in carrying iron ore. The coal trade was late in developing, and prior to 1860 no more than half-a-dozen steam vessels were devoted to it. It then grew more rapidly, and in 1868 19 vessels representing 65% of the west coast steam bulker tonnage were working in the coal trade. Vessels in the coal trade during the period had an average net tonnage similar to those in the ore trade, and again much smaller than their east coast equivalents. Coal was loaded largely in Cardiff, Newport,

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Hull to the Baltic and Mediterranean, Charente, and the Azores, whilst still fitting in the occasional sequence of

Liverpool, Preston, Whitehaven, Workington, Silloth, Ardrossan and Bowling, and was delivered to Cork, Dublin and Belfast. A particularly interesting voyage was that of the *Will o'th' Wisp* from Newcastle to Dublin in 1855;[31] if she was indeed carrying coal (as suggested by her regular route from Maryport to Dublin recorded in crew agreements), this much longer voyage indicates that carrying coal from the Tyne to Ireland in steamers was an economic undertaking.

Support for the findings that prior to the mid-1860s coal shipments across the Irish Sea were largely carried by sailing vessels comes from an editorial in a shipping newspaper for July 1865.[32] A prospectus issued by the Liverpool and Dublin Steam Navigation Company is quoted, a company floated by three railways and one canal company and intending to 'supply a more independent communication than now exists between England and Ireland, via Liverpool.' In addition to paddle vessels for this service, the company also intended to run screw colliers between the Mersey ports and Dublin, probably loading livestock on the return voyage. The prospectus claimed that Dublin, with a population of over a quarter of a million, and consuming 700,000 tons of coal per year, was almost entirely dependent on small sailing craft from the English and Scotch ports, which, being subject to the delays due to wind and weather, left coal imports uncertain and caused considerable fluctuations in price. The editorial concedes that screw colliers running out of the Mersey could prove remunerative if coal could be

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Middlesbrough to London voyages.
30. National Archives BT98/6546.
31. National Archives BT98/3921.
32. *Mitchell's Steam-Shipping Journal*, 7th July 1865.

procured as cheaply on the Mersey as it could be on the Bristol Channel, at Whitehaven, and the Scottish ports.

The internal trade in the Bristol Channel is the third important bulk trade for steamers on the west coast, and one which developed relatively early: the bulk-carrying steamer *Augusta* was crossing the Bristol Channel in 1850.[33] Coal was shipped from South Wales to ports on the north coasts of Devon, Cornwall, and Somerset including Devoran, Hayle, Bideford and Highbridge (the last named from Port Talbot in the *Dorset*,[34] probably for the locomotives of the Somerset and Dorset Railway). Back cargoes of copper or other ores were then carried to Swansea, Llanelly or Port Talbot for smelting. As early as 1850, *Augusta* was also making voyages to Rouen and London, making this Swansea-built vessel one of the real pioneers of bulk carrying by steam (initial cargoes were coal and copper ore according to her crew agreements, but *Augusta* later passed to iron master Henry Schneider, and entered the iron ore trade). The French voyages also demonstrate that west coast bulk carriers, like their east coast counterparts, were not confined to purely coastal voyages. Granite from Lundy was also being shipped to Appledore by the steamer *Vanderbyl*.[35] Figures in table A.7 indicate that Bristol Channel bulk carriers were typically smaller than other west coast bulk traders, probably reflecting the size of ports on the Cornish and Devon coasts. Bristol Channel traders accounted for around 20% of the total net tonnage of west coast bulk carrying steamers.

33. National Archives BT98/2230.
34. *Shipping and Mercantile Gazette*, 1st January 1869.
35. *Shipping and Mercantile Gazette*, 1st January 1867.

Two interesting specialised steamers figure amongst the Bristol Channel traders, the *Cuirassier* and *Edmund Ironsides*. They were designed to trade with china clay from Poole in Dorset up the River Severn to Stourport, where the china clay would be transferred to canal craft for transit on the Staffordshire and Worcestershire Canal (the vessels' owner was probably a nominee of the canal company, which feared rail competition).[36] Despite being designed with a sliding keel and other features to ensure a shallow draft, the steamers proved too deep drafted to carry a full cargo above Worcester, and were employed mainly between that town and Ireland and France.

Several east coast-built colliers were owned in Cardiff from 1865, the *Llandaff* and *Fairwater*, whilst the London-registered *Bwllfa* and *Merthyr* have names which suggest Welsh connections. Although no evidence has been found that these colliers traded on the west coast, the Cardiff-registered pair are included in the west coast figures. They appear to have been employed carrying coal from Cardiff and the east coast coal ports to ports on the Bay of Biscay (on one occasion returning from Bilbao with iron ore) and the Baltic. The London-registered pair also ran in the regular east coast coal trade to London, whilst those registered in Cardiff made an occasional voyage in the South Wales to south coast coal trade.

Four steamers have been found associated with short-distance trades out of the Rivers Mersey and Dee. The tiny *Llysfaen* of 1867 brought limestone and possibly granite from its owners' quarries on the North Wales coast to Mersey

36. Bradley, E., 'The Severn, as it was, as it is, and as it should be'. Paper read to the Worcestershire Naturalist's Club, 23rd March 1916.

ports.[37] *John Taylor* of 1866, *Aston* of 1867, and *Sea Swallow* of 1868 ran between the Dee and Mersey with ore and coal in connection with the businesses of their owners, who were involved in iron and lead.[38]

The steamship trade on the Clyde was probably in the hands of the 'puffers' whose size puts them below not only the 80 foot limit adopted for this survey, but seemingly also below the notice of agents who reported information for shipping newspapers and shipping masters who collected crew agreements. Only the tiny *Ariel* has been positively identified, running in the coasting trade from Port Dundas (on the Monkland Canal) to Fleetwood and Morecambe,[39] and this in 1860 before she was lengthened to over 80 feet.

Confirmatory evidence on numbers of bulk-carrying steamers

A Parliamentary Paper provides confirmation that steamers played very little part in the bulk trades between the west coast of England and Wales and Ireland up to the 1870s.[40] The paper includes a return of the number of voyages made by steam vessels between the various ports on the west coast of England and Wales and Ireland in the three years from 1870 to 1872.

The yearly averages of around 5,200 steamer voyages are made almost exclusively from ports that are known to participate in the liner trade. Thus exactly half the voyages end in Liverpool (sailings by, amongst others, the British and Irish Steam Packet Co. Ltd., the Belfast Steamship Co. Ltd. the City of Cork Steam

37. Fenton, R.S., *Mersey Rovers* (Gravesend, 1997), pages 188-93.
38. Fenton, R.S., *Cambrian* Coasters (Kendal, 1989), pages 46 and 130-5.
39. National Archives BT98/6850.
40. 'Returns of the Number of Voyages made by Steam Vessels between Ireland and the West Coast of England in each of the last Three Years, distinguishing the Voyages between the several Ports.' 31st March 1873 (126) LIX. 799.

Packet Co. Ltd.[41]), with Beaumaris coming a poor second with just over 700 steamer voyages a year, this port's total representing two sailings each day from Holyhead (which was within the customs port of Beaumaris) by London and North Western Railway steamers.[42] On average, one steamer leaves for Ireland each day from Lancaster (sailings from Heysham to Belfast by an associate of the Midland Railway[43]), Milford (sailings by the Great Western Railway[44]), Fleetwood (sailings to Belfast by steamers of the Lancashire and Yorkshire and the London and North Western Railway companies[45]) and Bristol (sailings to Cork, Dublin and Waterford by the Bristol General Steam Navigation Company[46]). But of ports known to be largely concerned with the coal trade, the numbers are much smaller. Chief of these is Cardiff, from where 133 voyages were made to Ireland in 1872. Whitehaven peaks at 125 voyages in 1872, Newport at 113 in 1872, Swansea at 101 in 1872, Maryport at just 14 in 1872, whilst Workington manages 37 in 1871, declining to 22 in 1872. The coal ports can be distinguished from packet ports because they show an imbalance between arrivals and departures, with more sailings to Ireland than from Ireland. This would be expected as back cargoes from Ireland to the coal ports were not generally available, and bulk carrying steamers therefore engaged in triangular trades, perhaps loading stone in North Wales after

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41. Chandler, G., *Liverpool Shipping: A Short History* (London, 1960), chapter 2.
42. Pearsall, A.W.H. and Davies, H.H., *The Holyhead Steamers of the L.N.W.R.* (Chorleywood, n.d.).
43. Duckworth, C.L.D. and Langmuir, G.E., *Railway and other Steamers* (Glasgow, 2nd ed., 1968), pages 26-33
44. Duckworth, C.L.D. and Langmuir, G.E., *Railway and other Steamers* (Glasgow, 2nd ed., 1968), pages 184-201.
45. Duckworth, C.L.D. and Langmuir, G.E., *Railway and other Steamers* (Glasgow, 2nd ed., 1968), pages 21-26
46. Jordan, E., *The Story of Lovell's Shipping* (Bristol, 1992), pages 9-17.

discharging coal in Dublin.[47] In contrast, with regular direct liner trade sailings from packet ports, the number of arrivals in these ports is very close to the number of departures.

It could be that the Liverpool figures may hide coal shipments, both from Liverpool itself, and from smaller ports within this customs port, especially Garston where the London and North Western Railway was developing facilities.[48] However, figures presented in the next chapter (figure 5.1) show that the tonnage of coastwise coal shipments from the Mersey in the early 1870s was less than a quarter of that from South Wales. If Cardiff, Newport and Swansea were not sending their coal to Ireland in steamers, there is no reason why Liverpool or Garston, with much smaller total shipments, should do so.

A total of just over 500 voyages were made by steamer from the coal ports to Ireland in 1872 (this figure may be increased slightly if steamers were running out of Liverpool or Garston with coal). Crew agreements for vessels such as the *Thomas Powell* indicate that she could complete a round trip from Cardiff to Cork in nine or ten days (the relative slowness being due to delays in the unloading port), making 30 to 40 voyages each year. The 1872 total of 500 voyages could therefore be accomplished by no more than 17 steam colliers dedicated to this trade. This tallies well with the 16 bulk-carrying steamers identified as running in the Irish Sea coal trade in 1870.

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47. Such triangular trades were the norm in the twentieth century for one of the largest west coast owners of bulk carriers, the Zillah Shipping and Carrying Co. Ltd. See Fenton, R.S., *Mersey Rovers* (Gravesend, 1997) pages 265-317.
48. Fenton, R.S., *Mersey Rovers* (Gravesend, 1997), page 20.

The tiny number of voyages to Ireland by steamer from the coal ports, 504 out of a total for steamers of 5,213 in 1872, should be contrasted with figures from another Parliamentary Paper which record 15,000 voyages to Ireland by sailing and steam colliers in 1864.[49] Clearly, in the early 1870s, steamers made only a tiny contribution to the carrying of coal to Ireland.

Further evidence for the numbers of screw colliers working on the east coast comes from a booklet compiled and published by London coal factor J.R. Scott in 1869.[50] Amongst other data, Scott lists the tonnage and number of voyages made by steam and sailing vessels to the port of London from 1854 to 1868. From the context of his book, this must be assumed to be voyages in the coal trade and the tonnages must represent coal carried. Smith notes a claim made in 1863 by William Cory to the Parliamentary Select Committee on the Thames Conservancy Bill that, 25 per cent of the coal arriving by sea in London was carried by screw collier.[51] Scott's figures make the 1863 total carried by steam 32 per cent. Scott shows that the first year in which coal carried to London by screw collier exceeded that brought by sail was 1865, with steam colliers bringing in 1,658,000 tons of coal, and sailing colliers 1,504,000 tons. In 1864, sail had beaten steam by a comfortable margin of almost 400,000 tons.

Do Scott's figures support the number of screw colliers in service as predicted by the methods used in this chapter? The year 1859 has been taken for comparison, as crew agreements for these years are available, and ten of these have

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49. 'Number of colliers laden with coal entering ports in Ireland during 1864' PP 1865, L, 529
50. Scott, J.R, *An Epitome of the Progress of the Trade in Coal to London since 1755.* (London, 1869).
51. Smith, R., *Sea-coal for London: History of the Coal Factors in the London Market*, (London, 1961), page 292.

been found for steam colliers running between the Tyne, Wear or Tees and London throughout the year. The number of voyages made by each of the nine steam colliers in a 12-month period is shown in table 4.1.

Table 4.1. Voyages made during 1859 or 1860 by colliers running continuously in the coal trade. Figures from crew agreements held at the National Archives, class BT98.

Name	Number of voyages	Crew agreement
Black Boy	40	BT98/6168 (1859)
Black Boy	45	BT 98/6871 (1860)
Black Diamond	36	BT98/5026
Cochrane	43	BT98/6781
Countess of Durham	40	BT98/6365
Londonderry	41	BT98/5960
Lyon	30	BT98/5948
Ross D. Mangles	33	BT98/6360
Seaton	32	BT98/4972
Wearmouth	39	BT98/5183
Total voyages	**379**	
AVERAGE	**37.9**	

Referring to tables A.2, the number of screw colliers in service during 1859 is 56, and if continuously employed in the coal trade they would be capable of making a total of 2,122 voyages at an average of 37.9 voyages per collier per year. However, it is estimated that screw colliers were spending only 59 per cent of their time in the purely coastal coal trade, reducing the number of voyages in this trade to 1,252. This figure will include voyages to destinations other than London, and is compatible with Scott's figure for 1860 of 1,054 voyages to London by screw collier in 1860.

Conclusions

In both numbers of vessels and net tonnage, the east coast collier fleet was consistently much bigger than the fleet of steam bulk carriers working on the west coast of the UK during the period 1850 to 1870. This holds true even allowing for steamers whose trade remains undefined, and for east coast colliers spending some 40 per cent of their time, on average, in non-coastal trades.

Bulk carrying in steamers on the east coast was overwhelmingly concerned in conveying coal from the Tyne, Wear, Tees, and Goole to satisfy the enormous appetite of London. The bulk-carrying steamers, which almost doubled in average size during the period reviewed, quickly began to make voyages much further afield, to near-European ports, the Baltic, Biscay ports, and the Mediterranean. This meant that only about 60 per cent of the capacity of the steam collier fleet was devoted to coastal coal deliveries. The only other bulk trade on the east coast identified as employing steamers was ore carrying, and that used less than one tenth of the number of steamers carrying coal.

On the west coast, three distinct trades for bulk carrying steamers can be discerned. The first to develop was carrying Cumbrian iron ore to South Wales ports, often loading steam coal for Liverpool on the return voyage. Steamers began to carry coal from Welsh, English and Scottish ports to Ireland in significant numbers from the mid 1860s, and by 1870 this trade was more important than ore carrying. A number of smaller steamers traded with coal and ore around the Bristol Channel, and to a lesser extent in the Clyde, Mersey and Dee estuaries.

The closest comparison between the east and west coasts concerns those steamers carrying nothing but coal. When considering just these ships the contrast is vivid: some 200 steam colliers ran in the east coast coal trade at some time between 1850 and 1870, compared with a total of 28 smaller ships in the corresponding trade across the Irish Sea.

Chapter 5 continues the investigation by looking at the split of steam bulk carriers between east and west coasts beyond 1870.

CHAPTER FIVE: BULK CARRYING STEAMERS ON THE EAST AND WEST COAST, 1870 TO 1910

Chapter 4 established that far fewer bulk-carrying steamers were working on the west coast than on the east coast up to 1870. Published work indicates that the numbers of bulk-carrying steamers owned and working on the west coast grew considerably from 1870 until the First World War.[1] This chapter aims to quantify the number and tonnage of such steamers during this period and to compare them with similar figures for bulk-carrying steamers owned and working on the east coast. This will establish whether the numbers of such steamers on the West Coast did indeed grow after 1870, part of the hypothesis on which this thesis is based. Investigating the relative numbers and size, the builders and ownership patterns of these ships will also give an insight into how the steam bulk carrier developed after 1870, and whether differences emerged between the ships on the two coasts.

Methods of assigning vessels to the coasts

As discussed in Chapter 4, there are no simple methods of deciding which ships are working in the coastal bulk trades. Data in the shipping newspapers are patchy (not all ports were necessarily under observation) and the enormous quantity of information (newspapers listed the ships in certain ports on a daily basis) makes analysis difficult. Crew agreements sometimes indicate trades, but the names of

1. Waine, C.V. and Fenton, R.S., *Steam Coasters and Short Sea Traders* (3rd ed. Albrighton, 1994); Fenton, R.S., *Cambrian Coasters* (Kendal, 1989); Fenton, R.S., *Mersey Rovers* (Gravesend, 1997).

potential coastal traders need to be established before these can be accessed, and only a sample of about 25 per cent of crew agreements remain in the UK for the years after 1862.

The problem has been approached by looking at contemporary lists of owners and their fleets published in shipping registers in order to list candidate ships for the years 1880, 1890, 1900 and 1910. The assumption made is that an owner of a fleet would specialise in the liner trade (for which he would build up the necessary administrative infrastructure) or in the tramp trades (for which he would establish contacts with agents and brokers to obtain bulk cargoes).

Three shipping registers have been used. The *Liverpool Underwriters' Registry of Iron Vessels* was established in 1862 as a result of dissatisfaction with the classification of iron ships by the London-based *Lloyd's Register*. Comparison with contemporary *Lloyd's Registers* shows that the Liverpool volume listed a number of vessels which did not appear in the London register. The Liverpool books began listing ships by owner in 1874, whereas *Lloyd's Register* did not follow suit until 1876. The data in both registers was limited to details of owner, port of registry, builder, engines, and dimensions, and gave no indication of trade. *Lloyd's Register* did include a 'Destined voyage' column but this was discontinued after the 1873 edition, and only indicated the owner's intention for the ship's first voyage. Therefore, candidate steamers can be identified only by size and by ownership by a company or an individual known from published sources to be involved in the coastal bulk trade. In cases where this is insufficient (many owners have just one ship) further information on the ship is built up, including previous and subsequent ownership to determine if it was ever owned by a company whose trade is known, its builders, its fate (voyage and cargo are usually recorded for casualties), and (in extremis) searches through shipping newspapers and the crew agreements in the UK.

The second register used is *Lloyd's Confidential Index.* Published twice yearly from 1886, this was prepared for underwriters, and listed the ships over 300 tons in each owner's fleet, giving details of casualties and - for ships not in the home trade - details of voyages (although not cargoes). Thus, by default, ships in the home trade can be identified. Home trade limits extended from Brest to the Elbe, and therefore ships running not just in the coastal trade but also to near-continental ports as far north as Hamburg are caught by this net. It was found in Chapter 4 that east coast colliers spent 40 per cent of their time running to ports outside the UK, and this must be allowed for in deciding collier numbers and tonnages. However, colliers owned in west coast ports (especially South Wales) were also employed carrying coal to overseas ports as far south as Brest.

Lloyd's Confidential Index omits a number of the smaller steamers which may be important in the west coast trade, and so *Lloyd's Registers* have also been searched for owners with ships suitable for coastal bulk trades. *Lloyd's Register* also provided figures for building dates, gross and net tonnages, lengths and builders. This register also gave useful detail on propulsion, enabling paddle steamers to be eliminated and, by 1890, listed the number of decks, allowing vessels to be eliminated which have more than one deck and are, therefore, probably intended for the liner trade. Tugs and trawlers were also identified in *Lloyd's Register* and can be eliminated.

Using these methods it has been possible to assign the great majority of the coastal bulk carriers to east or west coast trades. A difficulty arises with a small number of London-owned vessels which are not obviously east coast colliers and could trade on either (or both) coasts. They have been assigned to 'London'. The limitations of assigning ships in this way have already been addressed in Chapter 4. Ships, and especially steamers, can move from one coast to another in a matter of days, so strict assignment to one or other coast is not necessarily robust. However, as has been shown,[2] owners did tend to specialise in one geographical area, usually based on their home port, so the method offers the best available approximation for quantifying steamers working on the two coasts.

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2. Waine, C.V. and Fenton, R.S.; Macrae, J.A. and Waine, C.V., *The Steam Collier Fleets* (Albrighton, 1990).

Results

Table 5.1. Numbers, length, tonnages and year of build for coastal bulk carriers in service 1880

Candidate vessels identified as described in the text, with characteristics as recorded in registers.

		East coast	West coast	London
Number		280	184	16
Length	average	190 feet	140 feet	156 feet
	median	195 feet	141 feet	152 feet
Net tonnage	total	125,826	34,019	4,744
	average	447	184	279
	median	454	149	195
Gross tonnage	total	190,894	54,818	7,186
	average	684	296	423
	median	697	247	360
Year built	Average	1863	1871	1870
	median	1871	1873	1870

Table 5.2. Numbers, length, tonnages and year of build for coastal bulk carriers in service 1890

		East coast	West coast	London
Number		260	233	16
Length	average	195 feet	148 feet	179 feet
	median	199 feet	145 feet	178 feet
Net tonnage	total	123,186	47,786	5,608
	average	476	196	351
	median	459	148	351
Gross tonnage	total	192,937	89,367	8,931
	average	745	366	558
	median	771	307	543
Year built	Average	1873	1878	1878
	median	1873	1881	1881

Table 5.3. Numbers, length, tonnages and year of build for coastal bulk carriers in service 1900

		East coast	**West coast**	**London**
Number		258	272	37
Length	average	204	152	174
	median	205	152	175
Net tonnage	total	136,985	48,698	12,120
	average	533	178	328
	median	513	152	314
Gross tonnage	total	219,976	110,646	21,900
	average	856	405	592
	median	805	405	551
Year built	Average	1883	1886	1885
	median	1878	1886	1885

Table 5.4. Numbers, length, tonnages and year of build for coastal bulk carriers in service 1910

		East coast	**West coast**	**London**
Number		259	332	20
Length	average	212	164	190
	median	217	164	190
Net tonnage	total	157,989	70,260	7336
	average	612	212	386
	median	573	166	391
Gross tonnage	total	261,907	169,664	14,211
	average	1015	511	748
	median	946	440	763
Year built	Average	1891	1894	1894
	median	1894	1894	1899

Table 5.5: Summary of numbers, length and tonnages for coastal bulk carriers in service 1870, 1880, 1890, 1900, 1910

A summary of tables 4.1 to 4.4, with 1870 figures from tables A.1 and A2 (Appendix 1). 'WC/EC%' expresses the west coast figure as a percentage of the east coast figure. For instance, in 1870 the total number of west coast vessels was 28% of the total of east coast ships.

Year		**1870**	**1880**	**1890**	**1900**	**1910**
Number	West	37	184	233	272	332
	East	135	280	260	258	259
WC/EC%		27%	66%	90%	105%	128%
Total net	West	7,316	34,019	47,786	48,698	70,260
	East	65,880	125,826	123,186	136,985	157,989
WC/EC %		11%	27%	39%	36%	44%
Average net	West	197	184	196	178	212
	East	488	447	476	533	612
WC/EC%		40%	41%	41%	33%	35%
Average length	West	137 feet	140 feet	148 feet	152 feet	164 feet
	East	185 feet	190 feet	196 feet	204 feet	212 feet
WC/EC%		74%	74%	76%	75%	77%

Tables 5.1 to 5.4 are summarised in Table 5.5, with key data from this table displayed graphically in Figures 5.1 to 5.4. Over the period 1870 to 1910 the number of steam bulk carriers working on the west coast initially increases rapidly, from 37 in 1870 to 184 in 1880, and then continues to increase, steadily but more slowly, to 1910. The rate of growth in numbers from 1880 is about fifty ships per decade. The number assigned to east coast trades shows a similar rapid, early growth (beginning much earlier than the growth on the west coast as discussed in Chapter 4) up to 1880 after which the numbers decline slightly

through to 1910. Between 1890 and 1900 the numbers of west coast ships overtake those assigned to the east coast.

The total size of the east coast fleet, in terms of aggregate net tonnages, increases over the total period, with a slight downturn between 1880 and 1890. West coast net tonnages show a steeper rise, except for the period 1890 to 1900. However, the west coast aggregate tonnage is always much less than the east coast total, 11 per cent in 1870 and 27 per cent of the east coast total in 1880, and by 1910 has risen only to 44 per cent of the east coast total.

Those steamers which *Lloyd's Confidential Index* indicated were working in the Home Trade were identified as being coasters. Given the 'Brest to the Elbe' definition of Home Trade, clearly some of these vessels were trading to near-continental ports. Estimates from crew agreements suggest that 40 per cent of the east coast fleet was trading outside strict coastal waters in the period 1850 to 1870. If this situation maintains in the period up to 1890, there is still a much greater tonnage working on the east coast than the west. It must also be remembered that there were opportunities for west coast ships to go further afield, for instance carrying South Wales coal to French Channel and Biscay ports.

As would be expected from the above figures, the typical west coast ship is smaller than that on the east coast, both in terms of length and of net tonnage. Interestingly, the average and median net tonnages for west coast vessels actually fall from 1870 to 1880, the mean tonnages (but not always the averages) rising steadily after this date. Average and median lengths grow slightly from 1870 to

1880, and increase modestly for each decade thereafter. Net tonnage should be a better guide to carrying capacity than length, as it reflects the capacity of the holds, but as an indicator of size the net figure needs to be treated with some caution. Harbour and other dues were paid on net tonnage, so it was in the interests of shipowners and those who built for them to keep the measured net tonnage as low as possible consistent with establishing a good carrying capacity.[3] A number of devices were used to reduce the measured net tonnage, and registration documents record frequent changes in tonnages, almost always downwards without change in other dimensions. For instance, the *John Bowes* was measured at 375 net in 1852, yet by 1871 the figure had been reduced to 270.[4] The fall in net tonnages from 1870 to 1880 is more likely to reflect the success of measures to reduce the tonnage figure than an actual decrease in carrying capacity.

East coast vessels grow by 25 per cent in average net tonnage from 1870 to 1910, and by 15 per cent in length. The high average net tonnage of west coast vessels in 1870 makes a similar comparison less meaningful, but 20 per cent growth in average length is seen from 1870 to 1910. Overall, the differential in size between east and west coast ships is approximately maintained: average and median lengths of west coasts ships being around 75 per cent that of east coast ships. The differential in average and median net tonnages decreases slightly from 1880 to 1910. This would be expected, as net tonnage is a cube function of length

3. Waine, C.V. and Fenton, R.S., page 17.
4. Registration documents in class BT108, National Archives.

(assuming other dimensions increase in proportion), and lengthening the larger vessel by a similar amount to the smaller vessel would give a considerably larger increase in net tonnage.

Not surprisingly, given the spurt of building of west coast vessels in the 1870s, the west coast vessels are initially considerably younger; the median year of build in 1890 being 1881 compared with 1873 on the east coast. This difference decreases, and by 1910 the median year for both coasts is 1894. This reflects the explosion of coaster building for west coast trades between 1870 and 1890, and also suggests that the east coast fleet is being modernised in the decades from 1890 to 1910.

Vessels assigned to 'London' are intermediate between the size (and age) of east and west coast ships, probably reflecting a mix of ships suitable for west and east coast trades.

The difference in the average size of east and west coast ships indicates that shipowners are building smaller ships for the west coast, presumably because the trade demands small ships or offers these ships wider opportunities for trading. The enormous growth in the number of small ships being built, comparing the periods 1850-1870 and 1870-1890, strongly suggests that such smaller ships are becoming increasing economic. The growth in the size of the west coast fleet in this period was faster than the growth in trade, as investigated in Chapter 6, so factors other than availability of cargo must be at work. It is postulated that improvements in the technology of building hulls and engines in iron and steel were resulting in lower capital costs, greater efficiency, or both, and that this enabled the smaller bulk carrier needed for west coast trading to compete with the sailing ship. Chapter 10 will examine this postulate.

Summary and conclusions

The west coast bulk carrier was much slower to emerge than its east coast equivalent, and not until the decade 1870 to 1880 did it appear in significant numbers - 20 to 30 years after the east coast collier. Thereafter growth in numbers of the west coast fleet was rapid, and in numbers (although not in tonnage) the west coast fleet outgrew that on the east coast by 1900. This supports the second part of the initial hypothesis on which this thesis is based, that numbers of west coast bulk carriers grew significantly in the latter part of the nineteenth century.

Differences in size between vessels on the two coasts were significant, with west coast vessels having only 30 to 40 per cent of the carrying capacity and being around 75 per cent of the length of east coast steamers. These differentials were broadly maintained over the period 1870 to 1910.

The east and west coast bulk carriers were evidently quite different species of ship. The considerable differences which emerge help to validate the methods of assignment used in this study: if ships were working willy nilly round the coast, the differences would have averaged out. The technical differences between east and west coast ships, patterns of ownership and builder are explored in subsequent chapters.

Figure 5.1. Numbers of steamers in east and west coast bulk trades 1870 to 1910

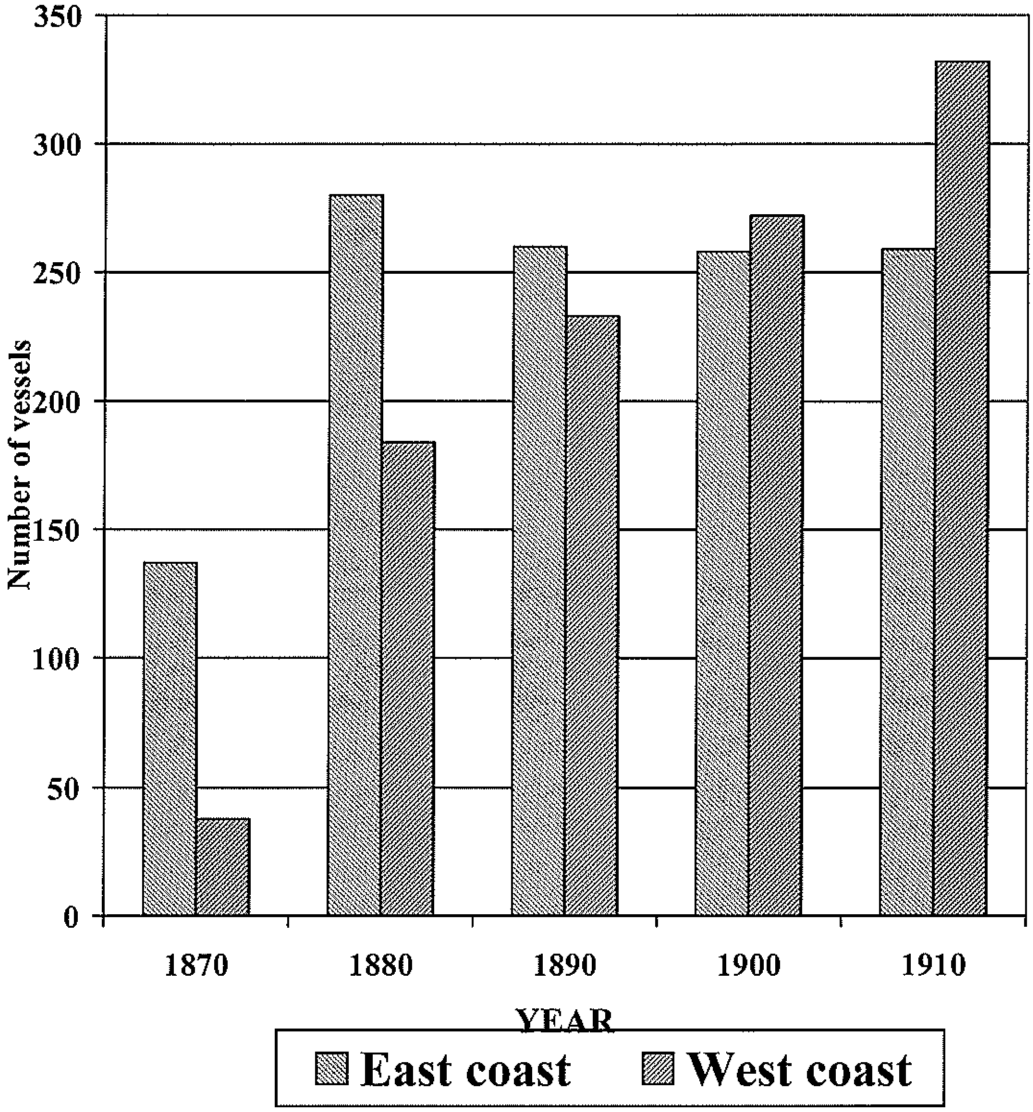


Figure 5.2. Aggregate net tonnages of steamers in east and west coast bulk trades 1870-1910

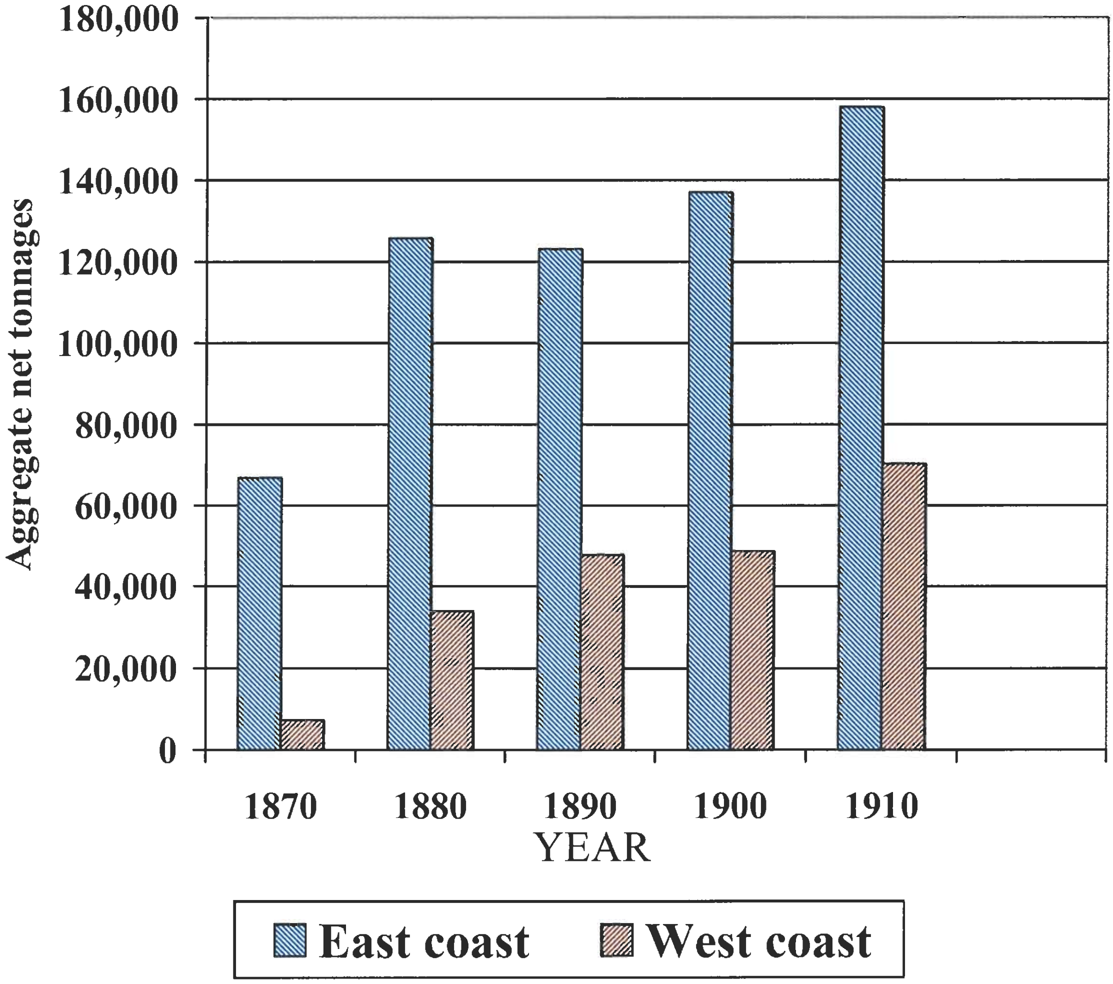


Figure 5.3. Average net tonnages of steamers in east and west coast bulk trades 1870-1910

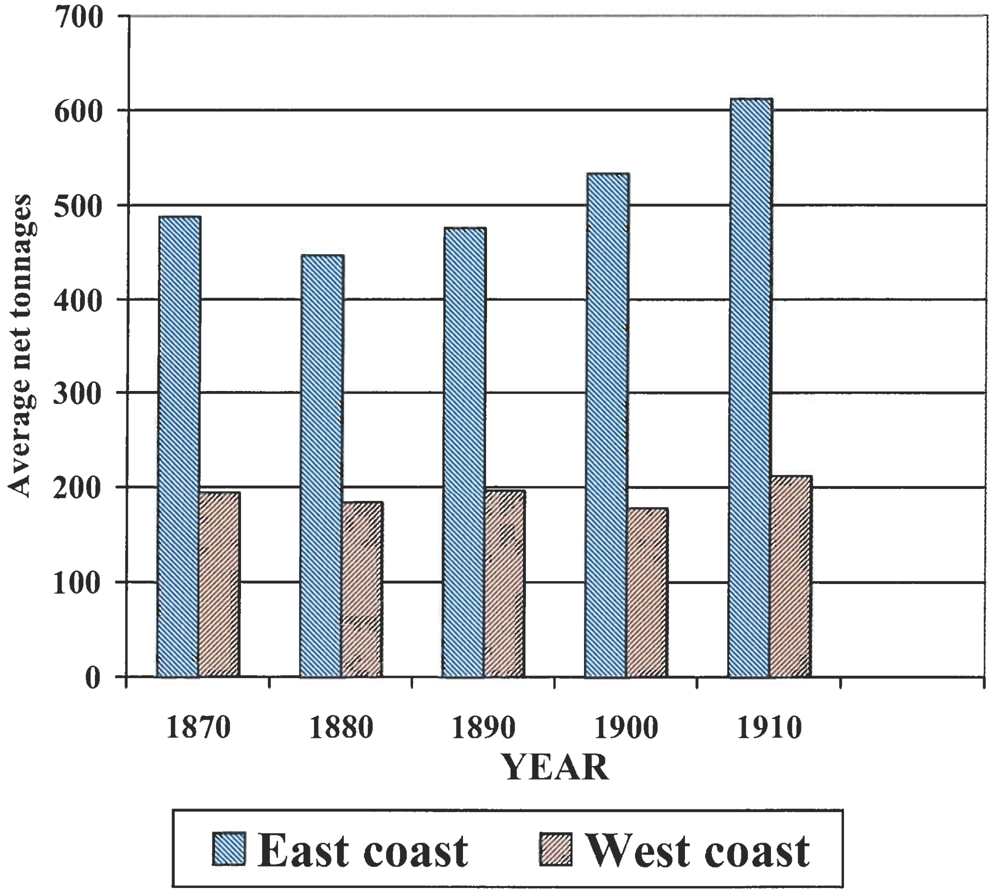
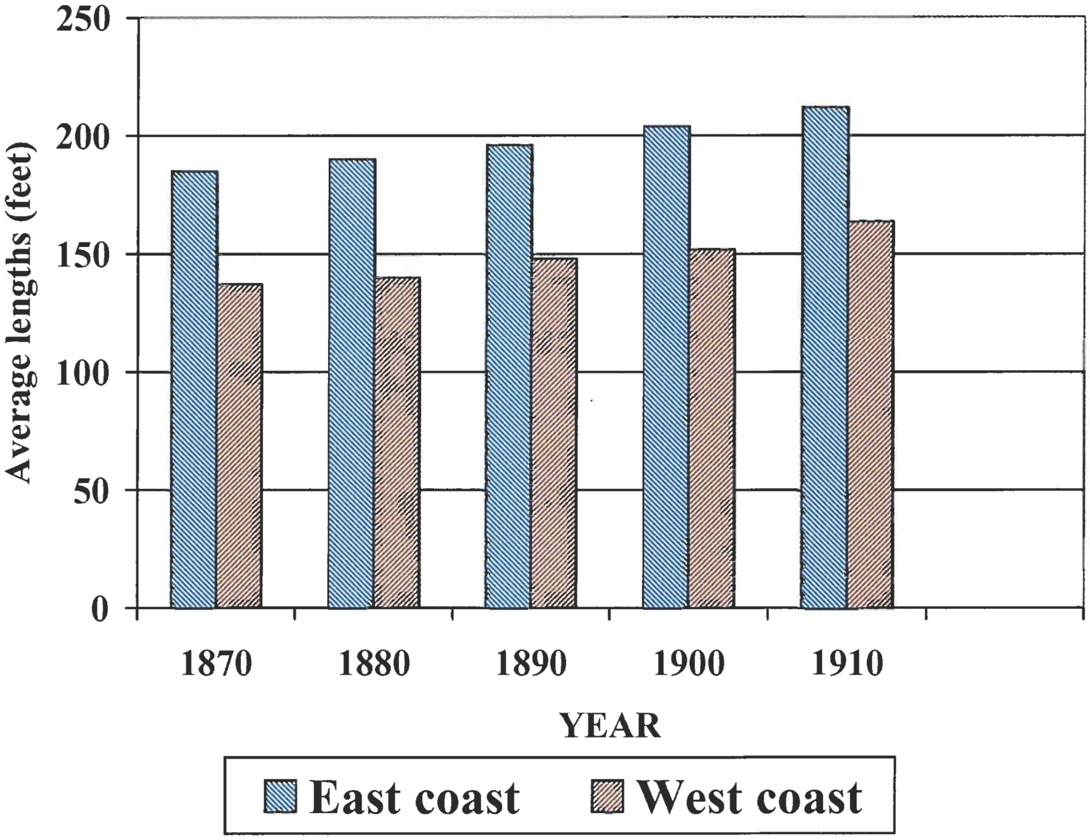


Figure 5.4. Average lengths of steamers in east and west coast bulk trades 1870-1910



CHAPTER SIX: THE GEOGRAPHY OF THE COASTWISE BULK TRADES

Before investigating further the disparity between the use of bulk carrying steamers in the east and west coast trades in the period 1850 to 1870 shown in chapter 4, it is necessary to look at two possible explanations for the inequality.

Firstly, was the volume of trade in bulk commodities on the west coast sufficient to sustain steam bulk carriers to the same extent as the east coast trade?

Secondly, did practices in west coast coal shipping and receiving ports discriminate against steamers?

The Coal Trade Act of 1730[1] made it unlawful for any vessel delivering coal to the River Thames to discharge out of turn, so colliers were unloaded in strict order of their sequence of arrival. The persistence of the turn system put steam colliers at a strong disadvantage. Because of their high capital and running costs, they could not remain unemployed for considerable periods whilst sailing ships were loaded or unloaded, the latter operation especially being prolonged because of the small hatch sizes of wooden sailing ships. The 1730 act specifically mentions the Thames, but there are suggestions that the turn system was adopted, although without the force of law, at coal loading ports. According to Craig, '...soon after the advent of the commercially successful steamship it became the custom at most coal-loading ports for steam

1. The Coal Trade Act, 1730 (4 Geo.2) CAP. XXX is popularly but incorrectly referred to as the 'Coal Turn Act'. It was enacted to make 'more effectual' an act passed the previous year, An act for better Regulation of the Coal Trade, 1729 (3 Geo 2) CAP. XXVI.

vessels to be given priority over sailing vessels, presumably in recognition of the greater capital embarked in the former, and no doubt a shrewd calculation by dock and harbour authorities that revenue would be increased by showing favour to steamships capable of rapid repeated voyages.'[2]

Owners of steam colliers trading to London had to get round the Coal Trade Act, and probably did so by discharging in the enclosed docks, the Act specifically mentioning the River Thames. However, William Cory's pontoons which began discharging colliers by steam crane in the 1860s were clearly in breach of the 1730 act, and - presumably following much lobbying by him and his associates - the Coal Trade Act was repealed in 1867.[3]

The second aim of this chapter is to investigate whether any such restrictive rules operated in the west coast coal-loading ports or in the major Irish ports receiving coal shipments. Strict enforcement of such rules could explain the finding in chapters 4 and 5 that the steam bulk carrier was not used in any significant numbers until the late 1870s.

Sources and methods

Volumes of trade

Throughout the period under review, Parliamentary Returns recorded the yearly tonnages of coal, culm, coke and patent fuels which were shipped coastwise from individual UK ports.[4] To compare volumes of coal being shipped, figures

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2. Craig, R., 'Aspects of tramp shipping and ownership' in Matthews K. and Panting G. (eds.), *Ships and Shipbuilding in the North Atlantic Region* (St. John's, Newfoundland, 1978), page 214.
3. The Statute Law Revision Act, 1867 (CAP. 59). Keys, D. and Smith, K., *Black Diamonds by Sea: North-east Sailing Colliers 1870-1880* (Newcastle, 1998), page 43 gives the date as 1865.
4. The nineteenth century returns of coal shipped and received were presented in the more or less annual Parliamentary Papers, *An Account of the Quantities of Coals, Cinders and Culm Shipped at the several Ports of England, Scotland, and Ireland, Coastways, to other Ports of the United Kingdom.*

at roughly five year intervals were collected, and summated to show annual quantities of coal shipped from different regions, and to give overall figures for west coast and north east coast coal ports. Similar figures for other bulk commodities, such as iron ore, china clay, stone and pig iron, have not been found, but so dominant was the coal trade that its size is believed to offer a fair comparison of the opportunities for bulk carrying on the two coasts.

Port practices

Evidence for the existence of a turn system, and its eventual abandonment, has been sought in the surviving records of the west coast ports which represented the two most prolific importers of coal in the latter part of the nineteenth century, Belfast and Dublin, and the west coast ports which were the major exporters to Ireland, Maryport and Whitehaven.

At Belfast in 1864, a total of 4,599 colliers imported 562,517 tons of coal, whilst in the same year in Dublin a total of 3,948 arrivals brought in 674,741 tons of coal.[5] By 1870, the ranking had reversed, and a rapidly industrialising Belfast was importing more coal than Ireland's capital.

Maryport and Whitehaven were two of the most important ports for the export of coal to Ireland in the mid-19th century (see table 6.1). The only west coast ports to exceed the quantities of coal shipped coastwise at Maryport were Cardiff and Newport, and much of this was steam coal going to London or to other ports, possibly as bunker coal. Other major north western ports,

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For the twentieth century, the returns appear as tables in the *Annual Statement of the Navigation and Shipping of the United Kingdom 1899.*

5. Account of number of colliers laden with coal and coke which entered ports of Ireland, 1864 **1865** (440) L.529

Workington and Liverpool (the latter's figures probably including shipments from the smaller Mersey ports such as Runcorn, Widnes and the recently-opened dock at Garston) were shipping only about a third as much as Maryport and half as much as Workington. Reports in the minutes of harbour authorities in Dublin and Belfast indicate that much of the coal arriving at these ports was indeed from Whitehaven and Maryport.

Surviving records from these Irish and English ports would be expected to refer to port practices such as a turn system, and any changes to such a system. With an average of more than ten coal-carrying vessels arriving at Dublin and Belfast each day, there would have been disputes referred to the harbour authorities, whilst harbour or berthing masters may have looked to higher authority for instructions. Letters and minutes of the harbour authorities would record such matters.

The National Archives in Dublin have full sets of minute books (referred to as 'journals') and letter books for the Corporation for Preserving and Improving the Port of Dublin for the 1860s and 1870s, the period when any change in the turn system could have been expected. These volumes are competently indexed, making a search feasible if time-consuming, as the bound volumes of the letter books and minutes run to 400-500 pages, and each cover a period of only 18-24 months. With limited time available in Dublin for this work,[6] the periods 1859-1866 and 1870-1881 were selected for coverage.[7] However, the impression from the minute books is that no radical changes

6. The author gratefully acknowledges a grant from the Tomlin Fund of the Society for Nautical Research which made this and the visit to Belfast possible.
7. National Archives, DPDB 1/25-1/28 and DPDB 1/31-1/36.

occurred in the intervening years. Letter books for the period 1859 to 1866 were also examined in parallel with the minutes.[8] As any issues raised were referred to the main committee, the minutes cover all matters and these alone were referred to for the 1870s. The indexes of these were scanned for any mention of the coal trade, disputes over berthing, for correspondence with coal merchants, with individual captains of vessels, and any mention of steamships (this was confined to correspondence with the steam packet companies serving Dublin). The minutes also gave an overall impression of the facilities available at Dublin for the coal trade, and an insight into the port authorities' attitude to this trade.

The records for the Belfast Harbour Commission for the late nineteenth century have not survived in such complete sequences. The Public Record Office of Northern Ireland (PRO NI) in Belfast holds letter books from 1837 to 1851, but there is a gap until 1912, the most interesting period for the present research. Minute books have not survived,[9] and accounts and annual reports only from 1884. The records described as 'Belfast Harbour Journal' which survive for 1864 to 1884, are annual accounts.

Records in the form of minute books survive in Cumbria Record Offices for the authorities which ran the harbours at both Maryport[10] and Whitehaven.[11]

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8. National Archives, DPDB2/1-2/6.
9. An officer of the Belfast Harbour Commission who was familiar with their records gave an assurance that everything surviving had been handed over to the PRO NI.
10. Minute books of the Maryport Harbour Trustees from 1833 to 1898 are in the Cumbria Record Office, Carlisle in the series SH2.
11. Minute books for the Whitehaven Town and Harbour Trustees from 1708 to 1894 are in the Cumbria Record Office, Whitehaven in series DH4.

The minute books of Maryport Harbour Trustees are indexed, and this allowed the entries from 1855 to 1882 to be searched.[12] The minutes of the harbour authority at Whitehaven, the Whitehaven Town and Harbour Trustees, are not indexed, but marginal notes indicate the subject of the adjacent paragraphs. Minutes from 1862 to 1884 were searched.[13] These minutes are strong on procedure but are usually silent on the discussions that must have taken place before decisions were made. However, as with other harbour authorities, it would seem that every letter written to the Trustees or one of the constituent committees is noted in the minutes, although not always with an outcome or action being recorded. It is probable that the minute books were open to public inspection, so perhaps it was felt unwise to reveal too much, or perhaps the clerk did not have the time or inclination to record further detail.

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12. Records of the Maryport Harbour Trustees searched were:

Minute Book No. 3 1855-1866	SH2 3/1
Index 1855-1866	SH2 3/2
Minute Book No. 4 1866-1874	SH2 4/1
Index 1866-1874	SH2 4/2
Minute Book No. 5 1874-1882	SH2 5/1
Index 1874-1882	SH2 5/2
In addition, the following were also searched:	
Harbour Committee Minute Book 1866-1880	SH2 13/1
Index 1866-1880	SH2 13/2

Earlier minute books for the Harbour Committee are not listed in the Cumbria Record Office catalogue. There are very few other records of the Maryport Harbour Trustees for the 19th century, most of those surviving in the Cumbria Record Office being from the Harbour Commissioners who took over responsibility for the port in 1898.

13. Records of the Whitehaven Town and Harbour Trustees searched were:

Minute Book 1862-1874 DH4/4
Minute Book 1874-1884 DH4/5
Harbour Committee Minute Book 1958-1869 DH4/9 This was only part searched, as the Committee's remit seemed to be limited to routine matters such as payment of salaries, and any issues were referred to the meetings of the Trustees.

Table 6.1. Tons of coal shipped coastwise from west coast ports in 1854

Source: *An Account of the Quantities of Coals, and Patent Fuel shipped at the several Ports of the United Kingdom Coastways for 1854,* Parliamentary Papers 1854 **1854-55** (287) L.355

Port	**Tonnage**
Newport	506,435
Cardiff	481,353
Maryport	304,197
Llanelly	266,402
Swansea	255,984
Whitehaven	215,544
Workington	117,811
Liverpool	105,030

Comparison of east and west coast trades in coal

Figures given in Parliamentary Returns allow comparisons of the volumes of the coal trade on the east and west coasts (table 6.2 and figure 6.1).

Table 6.2. Coastwise coal shipments from ports on the west coast of the UK and the north east coast of England 1847-1910 (100,000 tons)

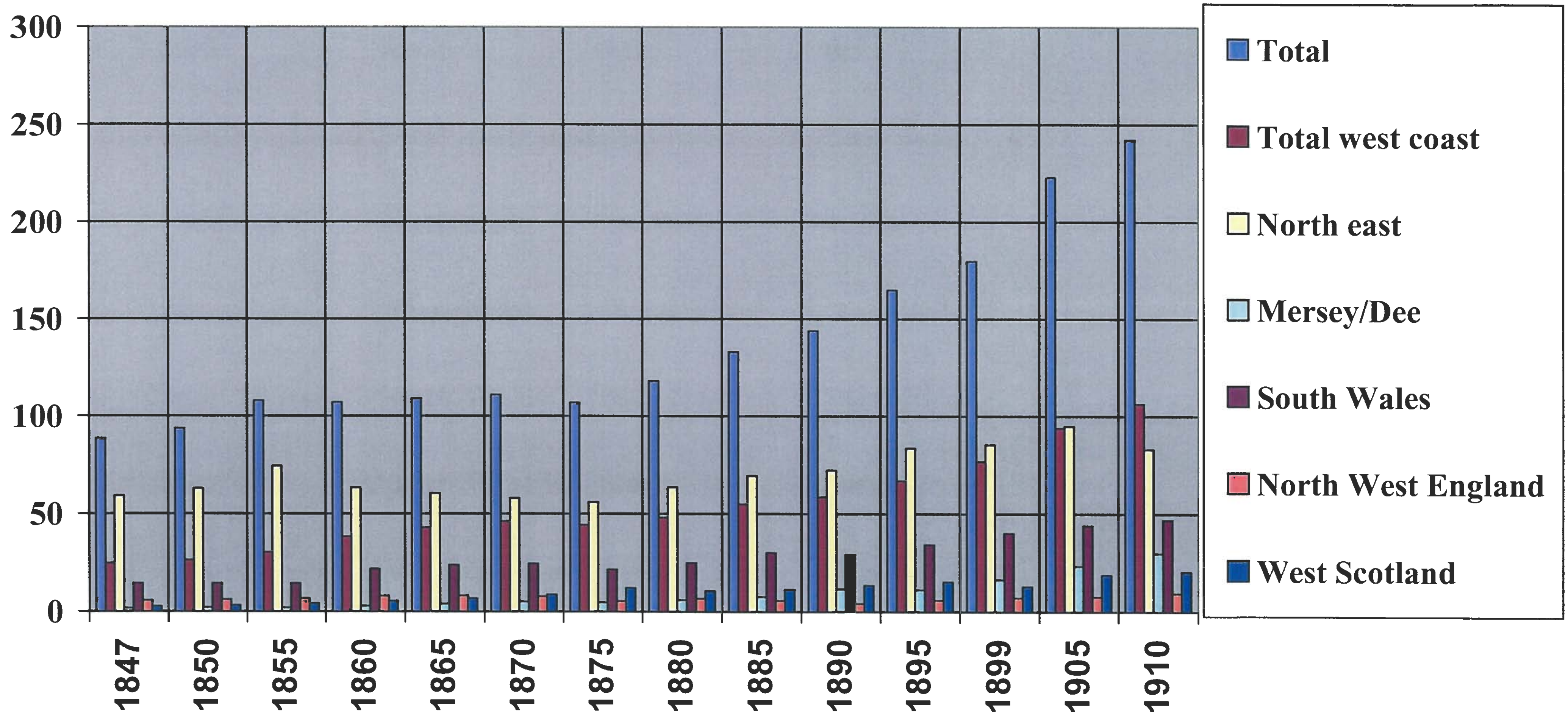
Total includes coal, cinders, culm, and patent fuel. Percentages shown (in right hand of column pairs) are of total UK coastwise shipments.

Source: *An Account of the Quantities of Coals, Cinders and Culm Shipped at the several Ports of England, Scotland, and Ireland, Coastways, to other Ports of the United Kingdom* Parliamentary Papers (see Bibliography for full citations)

Year	1847		1850		1855		1860		1865		1870		1875		1880	
North west England	5.7	6%	6.3	6.7%	6.8	6.3%	8.1	7.5%	8.3	7.6%	7.9	7.1%	5.5	5.1%	6.7	5.6%
Mersey and Dee	1.7	1.9%	2.1	2.3%	2.0	1.8%	2.9	2.7%	4.0	3.7%	5.1	4.6%	4.8	4.5%	6.0	5.1%
South Wales	14.5	16%	14.5	15.5%	14.5	15.5%	21.9	20.4%	23.8	21.8%	24.6	22.1%	21.6	20.1%	25.0	21.1%
West Scotland	2.8	3%	3.3	3.6%	4.2	3.9%	5.5	5.1%	6.9	6.3%	8.7	7.7%	12.3	11.4%	10.5	8.8%
Total west coast	24.7	28%	26.3	28%	30.3	28%	38.4	35.8%	43.0	39.4%	46.2	41.6%	44.3	41.2%	48.1	40.7%
North east England	59.2	67%	63.0	67%	74.4	69%	63.3	59.0%	60.4	55%	58.0	52%	56.0	52%	63.6	53.7%
Total UK	88.7	-	93.7		108		107.2		109	-	111	-	107	-	118	

Year	1885		1890		1895		1899		1905		1910	
North west England	5.7	4.3%	4.3	3.0%	4.3	3.0%	7.2	4.0%	7.8	3.5%	9.5	3.9%
Mersey and Dee	7.6	5.7%	11.6	8.0%	11.3	6.9%	16.5	9.1%	23.3	10.5%	29.8	12.3%
South Wales	30.2	22.7%	29.3	20.3%	34.3	20.7%	40.2	22.4%	44.0	19.7%	46.8	19.3%
West Scotland	11.4	8.5%	13.5	9.3%	15.3	9.3%	13.0	7.3%	18.9	8.5%	20.3	8.4%
Total west coast	55.0	41.3%	58.6	40.7%	66.9	40.5%	76.8	42.7%	94.1	42.2%	106.4	43.9%
North east England	69.4	42.1%	72.3	50.2%	83.7	50.6%	85.4	47.5%	94.9	42.5%	83.0	34.3%
Total UK	133	-	144	-	165	-	179.8		223.1	-	242.3	-

Figure 6.1. Coastwise coal shipments in 100,000 tons 1847-1910



Notes on table 6.2 and figure 6.1

Five yearly samples have been taken, with the exception of 1847 (the first set of figures presented in Parliamentary Papers), 1899 (figures for 1900 not found) and 1913 (the figures for 1914 do not appear to have been presented, presumably because Parliament had more weighty matters on its mind in 1915 and 1916).

North west England includes Carlisle, Maryport, Workington, Whitehaven, Lancaster, Barrow-in-Furness, Fleetwood and Preston.

Mersey and Dee includes Chester, Liverpool, Runcorn (in some years only) and Manchester for 1900 onwards. Figures for Garston are not quoted separately, and it is presumed they are included in the Liverpool totals. Widnes was also a significant coal exporter, but it is not known where its figures are included.

South Wales includes Cardiff (the largest coal shipping port on the west coast from 1865), Newport (the largest on the west coast until 1865), Swansea, Neath, Port Talbot, Porthcawl, Llanelly and Milford.

Total west coast includes all the above, but not Gloucester or Bristol.

North east England includes Amble, Blyth, Newcastle, North and South Shields, Sunderland, Hartlepool, Middlesbrough, and Stockton. From 1850, Newcastle is the largest shipper, indeed the largest shipper of coastwise coal in the UK (with in 1855 four times the tonnage of the largest west coast port, Newport, and in 1890 still three times the tonnage of its nearest rival, Cardiff), but is challenged by Sunderland (the leader in 1847).

West Scotland includes Greenock, Glasgow, Campbeltown, Ardrossan, Troon and Ayr.

The purpose of this exercise is to compare the volumes of coal emanating from the north east English ports with those coming out of west coast UK ports, and hence omitted from this analysis are ports serving two other coal producing regions, the Humber ports - Goole, Hull, Grimsby and later Immingham - and the east coast Scottish ports. Both groups were relatively small coal shippers in the period up to 1870.

Size and growth of east and west coast coal shipments

The figures in table 6.2 confirm the importance of the coastwise trade in coal. Not until 1870 do coal exports, at 11.5 million tons exceed coastwise shipments, at 11.1 million tons.[14] Even then, coastwise coal shipments continue to grow, increasing by 273% over the period 1847-1910.

Almost throughout the period, the north east coast ports dominate the trade, and only in 1910 are shipments from all west coast ports larger than those from the Tyne, Wear and smaller ports of Northumberland and Durham. However, growth in shipments from east coast ports at 140% was much less than the overall growth rate, and represented the smallest growth rate amongst the areas surveyed, even less than the north west of England (167%). Indeed, for the period 1855 to 1875 there is an absolute decline in coal moving coastwise out of east coast ports, possibly due to more coal being exported.

Newcastle and Sunderland were the most important coastwise shippers, and remain so, albeit by a declining margin, throughout the period reviewed. Their only rival was Cardiff which in 1910 approached them in tonnage with 2.7 million tons, compared with Newcastle's 2.9 million and Sunderland's 2.8 million tons. However, by 1910 South Shields is fourth in the league table with 2.4 million tons, making the total shipped from the Tyne a very impressive 5.3 million tons. The dominance of the coal trade by the adjacent rivers of the Tyne and Wear, and by a wide margin (in 1870 Cardiff's coastal trade was the

14. *An Account of the quantities of Coals, Cinders and Culm, and Patent fuel, Exported from the United Kingdom to Foreign countries and British settlements Abroad.* 1865, 1870, 1875

equivalent of just 35% of Newcastle's trade), may well have had an influence on the early adoption of the screw collier on the east coast.

Over the full period, shipments from west coast ports grew very strongly, their growth rate at 431% being higher than the overall growth rate of coastal coal shipments. Of the regions making up the overall west coast trade, growth from the Mersey and Dee ports, a massive 1,753%, was the largest, although this was exaggerated by a relatively late surge from 1880 coinciding with the development of loading facilities at Garston by the London and North Western Railway. By 1910 coastal coal shipments from the Mersey and Dee were 64% of the size of those from South Wales, which showed a more modest but still impressive 322% increase over the period reviewed. Growth from the west of Scotland (725%) was also very strong, and again showed a late surge from about 1880.

Coal shipments from west coast ports increased most impressively during the period 1847 to 1870, these ports improving their share of the total coastwise coal trade from 28% to 41% (by 1910 its share had grown only to 43.9%). At 4.6 million tons, the west coast coal trade was about 80% of the size of the east coast trade, surely large enough to justify the same investment in screw colliers as had been seen on the east coast. Chapter 4 showed that during the period of rapid growth in the 1850s and 1860s steamships had a very small share of the west coast trade. Much of this growth in the coal trade, therefore, took place without the benefit of steam colliers, and neither does it seem to have particularly stimulated the use of such vessels. There must be reasons other than sheer volume of trade for the slow adoption of the screw collier by west coast interests.

Ports receiving coal

The trade figures cited above indicate the port of origin of coal shipped coastwise, but not the port which is receiving the coal. A Parliamentary Paper lists the Irish destinations of colliers for 1864[15] (see table 6.3) and the Parliamentary Returns also give figures for coal received coastwise in various ports from 1870.[16] From these sources it is possible to draw some inferences, based on reasonable assumptions about coal flows.

Table 6.3. Colliers serving Ireland in 1864 and tonnages delivered

Source: *Account of number of colliers laden with coal and coke which entered ports of Ireland,* Parliamentary Papers, 1864 **1865** (440) L.529

Port	**Number of colliers in**	**Tonnage of coal in**	**Percentage of total coal tonnage**	**Average tons/collier**
Dublin	3,948	674,741	31.9%	171
Belfast	4,599	562,517	26.6%	122
Cork	1,452	264,199	12.5%	182
Newry	921	100,680	4.8%	109
Waterford	838	120,014	5.7%	143
Strangford	449	40,503	1.9%	90
TOTAL	**15,087**	**2,112,315**		**140**

In 1870, London completely dominated other ports as a destination for coal, with just under 3 million tons, 28% of all coal shipped coastwise. Its rivals on the mainland were Rochester (0.42 million), Bristol (0.3 million), Plymouth (0.28 million), Southampton (0.25 million), Bridgwater (0.27 million),

15. *Account of number of colliers laden with coal and coke which entered ports of Ireland, 1864* **1865** (440) L.529.
16. *An Account of the Quantities of Coals, and Patent Fuel received Coastways at the several Ports of the United Kingdom 1870.*

Aberdeen (0.22 million), Portsmouth (0.21 million), Dundee (0.19 million), Hayle (0.19 million) and Liverpool (0.17 million). The last-named port, Liverpool, was a coal exporter, but was also importing South Welsh coal, almost certainly for ships' bunkers. The major Irish ports, Belfast (0.79 million) and Dublin (0.76 million) ranked second and third overall for UK coal imports, with Cork also a major player (0.31 million).

Table 6.4 shows how coal imports fluctuated for London, for these three major Irish ports and, as comparators, Rochester and Southampton.

Table 6.4. Coastwise coal shipments received by London, Dublin, Belfast, Cork and Southampton for 1870-1910 (100,000 tons).

Source: *An Account of the Quantities of Coals, Cinders and Culm Shipped at the several Ports of England, Scotland, and Ireland, Coastways, to other Ports of the United Kingdom.* Parliamentary Papers. See Bibliography for full citations.

	1870	1875	1880	1885	1890	1895	1899	1905	1910
London	29.9	31.3	37.1	45.6	48.2	68.6	75.4	85.0	90.0
Belfast	7.9	7.9	8.8	10.0	11.7	13.3	14.5	15.2	16.7
Dublin	7.6	7.9	8.6	9.0	9.6	10.2	11.1	10.9	12.2
Cork	3.1	2.5	3.0	3.5	3.9	4.1	4.4	4.5	4.9
Southampton	2.5	2.2	2.5	2.9	2.0	4.6	5.2	8.1	7.2
Rochester	4.2	4.6	5.6	5.1	6.2	6.2	5.9	6.6	6.4
Total Ireland	**25.7**	**25.9**	**28.6**	**31.7**	**28.6**	**38.4**	**41.0**	**42.8**	**47.9**
Total UK	**106.7**	**103.8**	**115.0**	**129.0**	**140.7**	**166.3**	**173.1**	**199.9**	**210.2**

Table 6.4 shows that Belfast, as an industrial city, had overtaken Dublin in its coal imports by 1870, and continued to grow much faster than Dublin or Cork. Belfast's growth of 211% in 40 years can be contrasted with growth of 160% for Dublin and with an English seaport, Southampton, whose seaborne coal shipments grew by 288% in the same period.

Table 6.5. Coal shipped coastwise to selected cities as a percentage of total coastwise coal shipments, 1870 to 1910.

Source: *An Account of the Quantities of Coals, Cinders and Culm Shipped at the several Ports of England, Scotland, and Ireland, Coastways, to other Ports of the United Kingdom.* Parliamentary Papers. See Bibliography for full citations.

Year	London	Belfast	Dublin	Cork	Total Ireland	Soton	Roch.
1870	28.0%	7.4%	7.1%	2.9%	24.1%	2.3%	3.9%
1875	30.2%	7.6%	7.1%	2.4%	25.0%	2.1%	4.4%
1880	32.3%	7.7%	7.5%	2.6%	24.9%	2.2%	4.9%
1885	35.3%	7.8%	7.0%	2.7%	24.6%	2.2%	4.0%
1890	34.0%	8.3%	6.8%	2.8%	20.3%	1.4%	4.4%
1895	41.3%	8.0%	6.1%	2.5%	23.1%	2.8%	3.7%
1899	43.6%	8.4%	6.4%	2.5%	23.7%	3.0%	3.4%
1900	42.5%	7.6%	5.5%	2.3%	21.4%	4.1%	
1905	42.8%	7.9%	5.8%	2.3%	22.8%	3.4%	3.3%
1910	42.8%	7.9%	5.8%	2.3%	22.8%	3.4%	3.0%

Soton = Southampton, Roch. = Rochester

The figures in table 6.5 show that seaborne coal imports into London grew much faster than those of Irish ports. The relative decline in coal imported into Dublin and Cork (where the quantity imported grew, but failed to keep up with the growth in the total amount moving by sea) is paralleled by similar trends in coal imports to two provincial English cities, Southampton and Rochester. Southampton may be an anomalous example, as the large fluctuations seen there may reflect changing requirements for bunker coal for the steam shipping using the port. Rochester is a closer parallel with Dublin and Cork, a city without heavy industry where coal met requirements for domestic use, agriculture, light industry (such as brewing) and transportation (railways, bunkers for steamships, and a few road vehicles).

Table 6.6. Coal received in Ireland as a percentage of total coal shipped from west coast ports.

Source: *An Account of the Quantities of Coals, Cinders and Culm Shipped at the several Ports of England, Scotland, and Ireland, Coastways, to other Ports of the United Kingdom.* Parliamentary Papers. See Bibliography for full citations.

Year	100,000 tons Ireland received	100,000 tons west coast shipped	Percentage
1870	25.7	46.2	55.6%
1875	25.9	44.3	58.5%
1880	28.6	48.1	48.8%
1885	31.7	55.0	57.6%
1890	28.6	58.6	48.8%
1895	38.4	66.9	57.4%
1899	41.0	76.8	53.4%
1905	42.8	94.1	45.5%
1910	47.9	106.4	45.0%

Figures in table 6.6 indicate that the coal imports of Ireland represented between 45% and 58% of total shipments from west coast ports in the period 1870 to 1910. It cannot be said that this actual percentage of west coast shipments went to Ireland, as coal from the north east of England and the east coast of Scotland probably accounted for some of the Irish imports, although given the distance involved this amount is likely to be small. This raises the question as to where west coast shipments were going. The figures in table 6.7 list coal imported into west coast ports for 1870, and compares the total with west coast shipments in that year.

Table 6.7. Coal shipped and coal received by west coast ports for 1870

Source: *An Account of the Quantities of Coals, Cinders and Culm Shipped at the several Ports of England, Scotland, and Ireland, Coastways, to other Ports of the United Kingdom.* Parliamentary Papers. See Bibliography for full citations.

Received by ports in range Hayle to Carlisle	1,381,618 tons
Received by ports in west Scotland	91,880 tons
Received by ports in Ireland	2,568,271 tons
Total received around Irish Sea	**4,041,769 tons**
Total shipped from west coast	**4,620,255 tons**
Difference	578,486 tons

The difference between the amount shipped from west coast ports and the amount received around the Irish Sea can be accounted for by coal moved from South Wales to London, and to other south coast ports. Southampton and Plymouth (which were nearer to South Wales than to the north east coast ports) were taking a total of 460,554 tons of coal from all coastwise sources in 1870, and ports in the range Truro to Dover took a total of 2,131,179 tons.

Physical aspects of ports

It seems unlikely that the physical aspects of ports, such as depth of water or size of locks, inhibited the west coast steam collier. The south Welsh ports were amongst the biggest coastwise shippers of coal, and they were also loading large steam ships which were moving coal to the Biscay ports, as well as a smaller number of good-sized colliers taking coal to London. Liverpool was a port that could accommodate the largest vessels then built. Likewise, the major Irish coal-importing ports - Dublin, Belfast and Cork - could and did take (and, in the case of Belfast, build) ocean-going vessels which were much larger than any screw collier wanting to enter these ports.

Practices in coal receiving ports

For the periods 1861 to1865, and 1869 to 1880, no references are found to any 'turn' system operating, proposed or even contemplated at Dublin. There are very many references to matters of similar importance - such as delays getting into berths, and removal of coal from quays following loading - and it appears that any letter sent to the port corporation is read out at a committee meeting, its contents summarised at the meeting, instructions about replying and action to be taken are recorded. Matters concerning the Custom House Dock, which opened during the 1860s, are considered by a separate committee, but their proceedings are recorded in the same minute books as the main committee. It seems inconceivable that, in the 17 years of minutes sampled, not one dispute occurs about berthing rights reaches the board. There is but one steam versus sail conflict, and this is an 1880 accusation by the disgruntled and soon-to-be bankrupted coal merchant John S. Campbell that his sailing vessels are being discriminated against, but this is firmly rejected by the board, who refer to a previous board decision on allocation of quay space to him and other merchants. Certainly, steamers are bringing in coal during this period; as early as 1865 the *Kirkless* was working for a subsidiary of the Wigan Coal and Iron Co. Ltd. whose coal trade is referred to in the minutes, the locally-built *Tolka* was owned in the port from 1869 and is also referred to in the minutes, the *Arbutus* is owned in Dublin by 1874 and probably earlier, Tedcastle's *Dublin* is mentioned, whilst local coal merchant Michael Murphy bought the *Foyle* in 1877.

References to coal are reasonably frequent, but do not reflect the full importance of the trade to the port: in 1861 it is acknowledged, in passing, that coal is the most important traffic at Dublin after the regular steam packet services. Many references to coal concern the commodity being left on quays for longer than the customary 48 hours allowed.

The recorded requests to the Corporation by coal merchants for increased quay space may explain the port's practice regarding coal. Each merchant is allocated a certain length of quay, and has this to himself. Thus, the order in which vessels bringing in coal are unloaded would be left entirely to the individual merchant. This would facilitate the use of steamers, as the merchant could give preference in discharging to capital-intensive steamers over sailing vessels. Indeed, up until the late 1870s there seems ample quay space for all the merchants' needs. The Corporation is able to meet every request they make for additional space until about 1879, when such requests are invariably turned down. The strong demand for coal-unloading space at this time is shown by the minutes for 1879, when John S. Campbell is seen not to be making full use of his allocation of quay space (he was made bankrupt during that year) and three other merchants (including shipowner/coal merchant Thomas Heiton) apply to use Campbell's space.

Before leaving Dublin, enquiries were made of two individuals who are well acquainted with the history of the port and its records, Niall Dardis, archivist to Dublin Port, and an amateur researcher Pat Sweeney. They were quite unaware of any 'turn system' operating in the port. Neither is such a system referred to in a recent history of the port of Dublin.[17]

Surviving records of Belfast Harbour Authority are so few that they do not allow an analysis to be made similar to that for Dublin. Letter books are available only up to 1851, too soon for any sail versus steam conflict. No reference to a turn system, or disputes over such a system, appear, but the period searched is so limited that firm conclusions cannot be drawn. There is but one reference to coal, a request in 1849 by coal factors that their unloading facilities be transferred back to their (unnamed) former location, which is refused. There is, however, a clue to the practices regarding coal imports in the accounts (called 'journals') for the late 1850s.[18] This ledger records rent paid to Belfast Harbour Commissioners, and lists the tenants. Of these, 20 are coal merchants listed by the 1859 Post Office Directory for Belfast and Ulster, and this represents 20 out of the 26 merchants listed (77%). Drawing a parallel with the practices in Dublin, it is probable that individual coal merchants were allocated quay space, where they regulated their own discharging operations. This had clear advantages to the harbour authority, who did not have to be bothered with disputes about precedence in unloading.

Four histories of Belfast port have been located, dating from 1895,[19] 1917,[20] 1947[21] and 1985.[22] Coal is acknowledged as the major import, but

17. Gilligan, H.A., *A History of the Port of Dublin* (Dublin, 1988).
18. PRO NI, HAR/1C/6/5.
19. Stewart, A.W., *Belfast Harbour: its History.* (Belfast, 1895).

there is little further reference to it in any of these histories, and nowhere do they refer to any special conditions (such as a turn system) applying to the coal trade. The source most likely to make reference to it is the 'The Belfast Merchants and Shipowners Almanac' of 1853, a 74-page publication which includes sailing directions for Belfast and other practical details, plus a calendar, a list of Belfast-owned ships, and a dissertation on tides. No mention is made of any 'turn' system being applied.

Support comes from the laws and byelaws of the port of Belfast. 'Belfast Harbour Acts 1847-1898'[23] has no mention of any provision to regulate berthing of ships, and various clauses devolve regulation of ships to byelaws set by the Harbour Commission. The only set of byelaws which have been found are for 1888,[24] and these make no mention of a turn system or, as would be likely by that date, preference being given to steam.

Also lacking from the minutes of Dublin harbour authority and from histories of Belfast port are any references to coal unloading machinery. The introduction of such equipment caused a stir in the Thames, and in Dublin and Belfast would not have gone unremarked in the harbour authority minutes. Mechanised unloading equipment quickly followed screw colliers on the Thames, to expedite unloading and meet the tight deadlines (usually three days)

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20. Owen, D.J., *A Short History of the Port of Belfast* (Belfast, 1917). Ironically in view of its title, this 1917 publication is the most detailed history, but concerns itself mainly with individuals and state occasions. In tone and appearance (it is written in a number of parts) it would appear to be reprinted from a series of newspaper articles.
21. Belfast Harbour Commission, *Belfast Harbour Commission Centenary 1847-1857* (Belfast, 1917).
22. Sweetman, R. and Nimmons, C., *Port of Belfast 1785-1985* (Belfast, 1985).
23. A bound volume, published by the Belfast Harbour Commission in 1898, it includes provisions of the Belfast Harbour Act of 1847 and amendments made in 1852, 1854, 1870, 1871, 1882, 1883, 1888, 1893, and 1898.
24. PRO NI, HAR/1A/5/3

insisted upon by the owners of these craft. For instance, by 1857, when a select committee of the House of Lords is taking evidence for a proposed Coal Whippers' Bill, coal merchant Thomas Charrington names some ten wharves where coal unloading machinery is sited.[25] Cory's first floating derrick, *Atlas*, was moored in the river in the early 1860s.[26] The absence of any mention of such machinery during the same period in Dublin and Belfast helps confirm the impression that steam collier had yet to make any impact on the coal trade around the Irish Sea.

Practices in coal shipping ports

A printed set of byelaws for Maryport harbour appears as an appendix to the minutes of Maryport Harbour Trustees in April 1858. 'Regulations for the berthing, loading and discharging of vessels' make it clear that vessels take turns to be dealt with in the following order:

1. All vessels coming in to discharge goods
2. All vessels loading a full cargo.
3. All vessels taking a part cargo, or fitting for a foreign voyage.
4. All light vessels.

There is no mention in these byelaws of preference being shown for steam vessels, although steamers were using the port: the Maryport Steam Shipping Company had been running the steamer *Cumbria* since at least 1855.

In the 27 years of minutes searched, there is but one entry referring to preferences or a turn system. A letter dated 4th April 1877 from the London

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25. Select Committee Report on Coal Whippers' Act, PP **1857** XII.
26. Smith, R., *Sea-coal for London: History of the Coal Factors in the London Market*, (London, 1961), page 291.

and North Western Railway and the Flimby Colliery Company which, according to the minutes, is '...complaining of undue preference being given to steamers and interference with the coal hurries in Elizabeth Dock.' Frustratingly, there is no reference to any discussion or action being taken, the minutes merely recording that the letter had been read. In cases such as this, where the judgement of the Harbour Master is being called into question, the Trustees invariably carry out an investigation. The lack of such investigation following this complaint suggests that an informal system was in operation where preference was given to steamers, but that this was not enshrined in byelaws and the Trustees were not inclined to have any discussion of it made public in minutes.

It is clear from this and several other entries that the coal hurries (loading facilities) were owned by the local railway companies, the Maryport and Carlisle Railway and the L.N.W.R., although berthing vessels was the responsibility of the Harbour Master appointed by the Maryport Harbour Trustees. For instance, in June 1866 the Maryport and Carlisle is asking permission for the coal hurries 'at the steamer shed' to be modified to suit the hatches of the steamer *Isabella Croll*. This split of responsibilities would, it is assumed, give considerable cause for disputes, but none other than the 1877 complaint have been found.

There are a number of entries which suggest that any requests made for modifying the turn system in favour of steamers, and complaints received about its misuse, would feature in the minutes. For instance, in January 1878 the manager of the Dundrum-owned steam collier *Lady Downshire* complain about it being placed on a foul berth to load. There is, too, little doubt that the berths at Maryport were congested. In March 1863 and again in December 1864, the Trustees receive memorials from Belfast shipowners, masters and merchants and local coal proprietors on the subject. The Trustees reply that 'The subject of increased accommodation has not ceased to occupy their attention...with the hope that ere long their finances may be in such a condition as to enable them to take steps for enlargement.' Iron companies also demand extra accommodation for handling iron ore. In the late 1860s begins a period of infighting which harms the prospects for extra accommodation. In 1865 the Trustees decide to apply for an Act of Parliament to obtain a loan of £80,000 from the Board of Trade to build a new dock. This is strongly opposed by local coal owners, presumably frightened at the additional charges imposed on vessels using Maryport by the need to pay interest on this proposed loan. The coal proprietors go so far as to promote their own bill to wrest administration of the harbour from the Trustees, who naturally resist this threat. With relations between harbour users and harbour administrators inevitable soured, enlargement has to wait until 1884 when the Senhouse Dock is opened.

It is just possible that arrangements for steamers to be given preference were incorporated in new byelaws approved and published by the Trustees in 1873. To draw these up, the Trustees requested copies of byelaws from Liverpool, Sunderland, Troon and Whitehaven; all except the first-named significant coal loading ports. Unfortunately, these byelaws do not appear in the minute books, and Cumbria Record Office does not have a copy.

The evidence from the Maryport minutes on practices which might harm or prefer steam bulk carriers is sparse. It is apparent, however, that there was no great call for steamers to be given preference, and there is but one complaint about the Harbour Master giving such preference, in 1877. It is tentatively concluded that so few steamers were using the port before the 1870s that the question of their needing preference over sail did not arise and that, when steamers began using the port more frequently in the 1870s, they were informally given preference over sail when necessary. By 1884, with the completion of the new Senhouse Dock - which is specifically referred to as offering accommodation for steamers[27] - it is likely that there was sufficient accommodation to meet the needs of most users.

As at Maryport, it is clear from the minutes of Whitehaven Town and Harbour Trustees that a turn system was in operation at Whitehaven.[28] However, there is no mention during the 22 years from 1862 to 1884 of any petitioning for steam to be given preference, or of complaints about the application of any system. Nor is there mention of any change by Scott-Hindson, a local historian whose competent work on the history of Whitehaven harbour made very extensive use of the Harbour Trustees' minutes and other

27. This is noted in anonymous papers compiled with notes on the history of Whitehaven as a port, and the effect of developments at Maryport, which were found in uncatalogued files on the harbour in the Cumbria Record Office at Whitehaven. These notes seem to have been well researched, but at least one of the references given, to 'Sea Breezes', volume XX, page 172, turns out to have been an article on shipbuilding at Whitehaven.
28. Not only in the minutes: Scott-Hindson, B., *Whitehaven Harbour* (Chichester, 1994), pages 50-51 sets out the complex 'Directions for the Turn of Coal Ships' agreed in 1724.

local sources.[29] Bulk-carrying steamers certainly used Whitehaven: the 1857-built *James Kennedy* is referred to in the minutes during 1867, and the *Annie Vernon* of 1856 and *Jane Bacon* of 1865 are mentioned as visitors in another source.[30]

One of the few references to steamers in the minutes is in a letter dated 20th April 1876 from James Little and Co. of Barrow-in-Furness, requesting concessions on harbour dues for their steamers. This was sympathetically received by the Trustees, who ask their solicitors to modify Section 25 of a Parliamentary Bill which is in preparation.[31] The matter is referred to a Harbour Dues Committee, but minutes of their proceedings have not been found.[32]

As at Maryport, there is one reference, although not in the minutes, which suggests a preference was eventually given to steamers, but it is a frustratingly vague one. The second part of an article in the *West Cumberland Times*, quotes a lecture delivered some years previously by J.R. Thompson: 'We watched what seemed large screw steamers appear on the scene, claiming precedence and attention in the matter of despatch which could not be disregarded.'[33] This could well refer to vessels in the liner trade: Scott-Hindson

29. Scott-Hindson, B.
30. Two lengthy articles in the *West Cumberland Times* of 25.1.1919 and 1.2.1919 quote a J.R. Thompson, who gave a lecture 'some years ago'. Thompson remembers the *Annie Vernon* and *Jane Bacon* as being the first two steamers to visit the port. From the 1865 building date of the latter, and the report of the *James Kennedy* in 1867, this would date the appearance of steamers at Whitehaven to between 1865 and 1867.
31. Presumably this was the failed Workington Town and Harbour Act of 1878.
32. It is probable that these deliberations were concerned primarily with Town Dues, levied at Whitehaven but not at Maryport, and which put the former port at a competitive disadvantage.
33. *West Cumberland Times* 1.2.1919.

mentions a number of steamer services conveying passengers from at least 1829.[34]

The absence of any other reference in the minutes to steamers, and particularly to giving them preference over sail, may be explained by Whitehaven's declining fortunes. It is said that after the opening of Queens Dock in 1876, trade collapsed.[35] However, decline was apparent considerably earlier. Figures for coal exports show that these declined from 232,000 tons in 1850 to 180,000 in 1858, and did not revive again until the 1890s, when they peaked at just under 300,000 tons.[36] Tonnages of iron ore shipped out actually exceeded those of coal in the 1860s, peaking at 338,000 in 1864, but thereafter declining very steeply, being all but halved by 1871. This decline in outward trade is linked with the establishment of an iron industry in West Cumberland, which consumed much of both the coal and iron ore won locally, leaving little surplus for export.[37] In addition, both the local harbours at Maryport and Workington, where dock facilities had been improved and which had better rail facilities than Whitehaven, took an increasing proportion of the coal trade and, later, benefited from the import of Spanish ore for the local iron industry.

At Whitehaven even more than at Maryport, there seems a notable lack of agitation for preference to be given to steamers. It is likely that, by the time steamers arrived in any numbers in the local bulk trades, decline in shipments of coal and ore meant that there was sufficient accommodation at the port to

34. Scott-Hindson, B., page 147.
35. *West Cumberland Times* 1.2.1919.
36. Uncatalogued notes in Cumbria Record Office, quoting *inter alia* Parrish, E.K., in *Whitehaven News*, 31.12.1932.
37. Scott-Hindson, B., page 142 et seq.

avoid any serious conflict, and only an informal system of giving precedence to steamers was needed.

Conclusions

The tonnage of coal shipped coastwise from west coast ports in the period 1847 to 1910 rivalled that shipped from the north east coast ports, so that by 1870 it was equivalent to about 80% of the north east coast total and had surpassed it by 1910. The volume of trade, therefore, would be expected to warrant the employment of steam coasters, with their supposed economic advantages, prior to 1870.

However, the pattern of trade on the west coast was very different from that from north east coast ports, where the Tyne and Wear dominated shipments, and London greatly surpassed other ports in tonnage received. In contrast, west coast shipments came from a number of ports with only Cardiff standing out, and went to an even larger number of ports. The largest shipping port was Cardiff, shipping 19.2% of west coast coal, and the largest receiving port was Belfast, taking a figure equivalent to15% of the total tonnage shipped from west coast ports. Trade from the mainland of Britain to Ireland accounted for only about half the coal shipped from west coast ports. A proportion - perhaps 15% - of this may have gone 'round the corner', as sailors described Land's End, to ports on the South Coast and especially London. However, between a third and a half of coal shipped on the west coast during the period 1870 and 1914 was true coastwise traffic and, like that on the east coast, subject to railway competition.

Extensive scanning of minutes and letter books of the harbour authority for much of the decades 1860 to 1880 has revealed no suggestion that a 'turn' system is in operation at Dublin nor that it needed to be repealed to give steamers priority. Instead, it seems that the coal merchants receiving cargoes were left to regulate the order in which ships were unloaded. Thus, there appears to have been no harbour practice or prejudice which militated against the adoption of steam. The evidence base for Belfast is much less extensive, and only allows a tentative conclusion that the situation was similar to that in Dublin.

Evidence is also lacking from the minutes of the authorities that ran two of the major west coast ports shipping coal to Ireland, Whitehaven and Maryport, that practices impeded the use of steamers in the coal or iron ore trades. There is weak circumstantial evidence that steamers were given informal precedence over sail at some point (before 1877 at Maryport), but there was evidently no concerted agitation for such a practice to be enshrined in port regulations or bye-laws.

The turn system was an artificial, man-made barrier that could, given sufficient will, be torn down overnight. The first port to abandon the system would attract steam colliers, cutting costs and increasing its own throughput. Coal-loading ports were certainly in competition: on the Mersey, for instance, the London and North Western Railway had opened facilities at Garston in direct competition with those at Liverpool,[38] and if a port saw advantages in abandoning old customs such as the turn system it would surely have done so.

38. Fenton, R.S., *Mersey Rovers* (Gravesend, 1997), pages 20-22.

The turn system did not inhibit east coast collier owners, who eventually got legislation affecting the Thames repealed. If collier owners on the west coast were as determined as those on the east, similar measures could have been taken.

It is concluded that there is no reason to believe that practices in the major ports shipping or receiving coal in the mid-nineteenth century in any way inhibited the adoption of steam on the west coast.

Neither the total volume of trade nor port practices on the west coast can explain the failure of steam bulk carriers to be adopted here in any numbers. However, the fragmented nature of the west coast trade, with many ports being involved in contrast to the huge flows from Tyne and Wear to the Thames, suggests that the west coast required a different size or type of vessel. This is explored in chapter 9.

CHAPTER SEVEN: OWNERSHIP OF STEAM BULK CARRIERS

A possible reason why the steam bulk carrier did not spread to west coast trades immediately it had been technically proven on the east coast was that it was not yet an economic proposition for a ship owner. The steamers may not have earned sufficient to pay running expenses of fuel, crew costs and repairs, to service their capital, and to provide a profit. This begs the question, did steamers spread rapidly on the east coast because they were operated as an adjunct to other, coal-related businesses, rather than themselves being profit earners? For instance, securing a particularly attractive market for coal, such as supplying a large gas works, may have been more important than making a profit purely from operating the ship.

To address this question, this chapter looks at ownership patterns of the east and west coast-owned bulk carriers, considering the ships owned in 1870 and, to track trends in the pattern of ownership, 1890. It also considers evidence from the surviving records of limited liability companies who built colliers, and from contemporary shipping journals.

Sources and methods

Ownership details are available from several sources, although these are to some extent inter-related, with the registration documents being the primary source, and other publications taking details from these.[1]

Registration documents

During the latter part of the nineteenth century, registration of UK ships was compulsory, with a registrar (usually a custom's official) appointed in all customs ports. Owners were obliged to provide the registrar with details of the construction of the ship, dimensions, ownership, any mortgages on the vessel. They also had to ensure these details were kept up to date, by advising of the sale of shares, change of manager, or of the ship's alteration, loss or demise. The registrar completed two copies of the registration form known as the transcript - was forwarded to the Registrar General of Shipping and Seamen in London. When details changed (and this usually meant a change in ownership, identifying each newly registered ship with port number for the year (e.g. London No. 253 of 1886). One copy was kept in the registrar's office, and the other - of shares or change in manager, or an alteration in tonnage due to a modification or survey)

1. There is no single published guide to this aspect of research, but the following guides to individual collections are useful sources of information:

Barriskill, D.T., *A Guide to the Lloyd's Marine Collection and Related Marine Sources at the Guildhall Library*. Guildhall Library Research Guide 7, Second Edition. (London, 1994);
Smith, K., Watts, C.T. and Watts M.J., *Records of Merchant Shipping and Seamen.* (Public Record Office Reader's Guide No. 20.) (London, 1998);
Infosheets 2, 10 and 44 Published by Lloyds Register of Shipping;
Havilland, E.K., 'Classification society registers from the point of view of a marine historian.' *The American Neptune* XXX (1970), 9-39.

they were entered on the registrar's copy and also on to transaction forms which were forwarded to the Registrar General.

Vessels were frequently re-registered. A sale might well involve transfer to an owner in another port, and this owner would usually re-register in his own custom's port. Apparently, this was not compulsory, as some ships remained in a port's registry long after they had been sold away, but many owners did transfer registration, presumably because it made dealing with officialdom in the form of the registrar easier as it could be done face-to-face. Local registration would be necessary to belong to a local shipowners' association or a mutual ship insurance club. In addition, registration in a local port whose name would be displayed on the stern made the owner and perhaps the crew feel a closer part of the local maritime community.

In the earlier part of the period under discussion vessels were frequently re-registered at the same port as previously following apparently minor changes in details such as tonnage. This may have reflected the instructions given to registrars, or misunderstanding of these, as the practice later died out, and the original registration form was simply amended with details of changes.

Since 1825, property in a ship was divided into 64th shares, even when a corporate body such as a limited liability company was the sole owner. A share (or a packet of shares) could also be in joint ownership, although it seems that only up to three owners of each share were generally permitted. Share ownership was recorded in minute detail, and sales of shares make up the great body of detail in the transactions. Particularly useful for the purposes of this chapter, the occupation of the shareowners was usually recorded, although they were self-described and could be delightfully vague: 'spinster', 'married woman' or 'gentleman' frequently occurring, whilst owners often progressed from 'merchant' to 'shipowner' from one registration of the vessel to the next. Use of these terms may also have been an attempt to cover up the actual position of a subscriber. For instance, in 1863 John Orwell Phillips described himself as a 'gentleman' when subscribing to five shares in the new collier *Ellen Sinclair*. Phillips was, in fact, the Secretary to the largest London gas producer, the Gas, Light and Coke Company, and this is confirmed by his giving his address as Horseferry Road, London, the company's head office.[2]

Each ship had to have a 'ship's husband' or manager, usually to take responsibility in the event of some catastrophe. This individual could be a major or minor shareholder or, in the case of a limited liability company, an official of that company. Often, the manager's position or occupation offers a guide to the business in which the ship will engage.

The registration documents record when and why the registration was closed. This may be because of transfer to another UK port, registration anew in the same port, breaking up, loss through a maritime or war cause, or sale to a 'foreign subject'.

2. Chesterton, D.R. and Fenton R.S., *Gas and Electricity Colliers* (Kendal, 1984), page 70.

Registration documents have survived in the National Archives and in a number of local record offices, libraries and museums. The transcriptions and transactions forwarded to the Registrar General up to 1890 form classes BT108 and BT109 in the National Archives. The transcripts (class BT108) are bound into books, by port and year, with annotations numbering the transactions which refer to the ship. The transactions are bound in overall numerical order (class BT109). From 1890 to 1955, transcriptions and transaction forms are bundled together for each ship and filed in class BT110. Separation of the transcripts and transactions into BT108 and BT109 for the majority of the period covered by this study makes investigation of ownership changes extremely time-consuming, as a transaction may well record an event as insignificant as the sale of just one 64th share. During a particular ship's lifetime there may be many hundreds of such sales, each requiring a separate transaction to be filed.

Some of the registration documents retained in the registrar's office have found their way into local archives. Usefully, the transactions are often recorded on the registration document itself, which makes tracing a ship's history much less laborious than using BT108 and BT109.

Survival of these registration records in places accessible to the public has been patchy. Those for London comprise class CUST 130 in the National Archives (which has been widely used for ownership research in this study). Newcastle and Sunderland records survive in Tyne and Wear Archives, those from

Liverpool in the Merseyside Maritime Museum, and from Hull in Hull Record Office.

The *Mercantile Navy List*

From 1850, ownership and other details of all British vessels were recorded in an annual Government publication, the *Mercantile Navy List*. The details provided grew over the first two decades of publication, and by 1871 included for steamers: name, official number, place and date of build, place and time of registration, rig, gross and net tonnages, dimensions, horsepower, construction material, and name and brief address of one owner and the name and address of the ship's manager. The owner recorded appears to be either the largest shareholder or the managing owner, and the information corresponds closely with that recorded in the registration documents. Although a very useful source of ownership and other information, the value of the *Mercantile Navy List* is reduced for the purposes of this study by its failure to list smaller shareholders and to record the owner's occupations. In addition, there is no reason given for vessels being removed from the *Mercantile Navy List* between annual editions. These deficiencies mean that the *Mercantile Navy List* cannot replace registration papers as a source of ownership details.

Lloyd's Register

Lloyd's Register dates from the 1750s, but for longer than its first century it confined itself to listing vessels classed by Lloyd's Register of Shipping, who surveyed and then classified ships for the guidance of underwriters. As competition with rival registers (notably the *Liverpool Underwriter's Registry of Iron Vessels* and the *Répertoire Général* of Bureau Veritas) intensified in the latter part of the eighteenth century, *Lloyd's Register* responded by increasing coverage, aiming to include all self-propelled seagoing vessels over 100 tons gross, worldwide. The amount of constructional detail recorded for individual vessels also increased during this period.

Compared with the *Mercantile Navy List*, *Lloyd's Register* gave additional details, including name of the builders of hull and engines, whilst the 'posted' editions recorded changes of name, tonnage, sales, losses or scrapping. The 'posting' was done by hand each week, with stickers being applied over the original entry or the page being stamped with amendments.[3]

Ownership or management recorded in *Lloyd's Register* does not necessarily correspond with that recorded on registration documents or in the *Mercantile Navy List*. *Lloyd's Register* will often name an unregistered company where the *Mercantile Navy List* cites an individual owner.[4] It would seem that *Lloyd's Register*, wishing to attract a clientele for its publications, lists the 'office'

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3. Information kindly supplied by Mrs Barbara Jones, Archivist of Lloyd's Register of Shipping, London.
4. For example, the collier *Belmont* of 1865 is listed in the 1879 *Mercantile Navy List* as owned by John Burns of Abchurch Chambers, London. The owner in *Lloyd's Register* is Fenwick and Co., London, at the same address. Listing by *Lloyd's Register* under the ownership by this informal 'company' continues until 1894 when *Lloyd's Register* lists Fenwick, Stobart and Co. Ltd., under whom ownership is listed until 1896 when the vessel is sold to Sweden. In contrast, the 1891 *Mercantile Navy List* indicates a change of registered ownership to Douglas W. Stobart, London in 1892, although this new owner records the same address as his predecessor, John Burns. For example, the collier *Belmont* of 1865 is listed in the 1879 *Mercantile Navy List* as owned by John Burns of Abchurch Chambers, London. The owner in *Lloyd's Register* is Fenwick and Co., London, at the same address. Listing by *Lloyd's Register* under the ownership by this unregistered company continues until 1894 when *Lloyd's Register* lists Fenwick, Stobart and Co. Ltd., under whom ownership is listed until 1896 when the vessel is sold to Sweden. In contrast, the 1891 *Mercantile Navy List* indicates a change of registered ownership to Douglas W. Stobart, London in 1892, although this new owner records the same address as his predecessor, John Burns.

of the owner, which is likely to be better known, and easier to contact, than the major shareholder listed in the *Mercantile Navy List.*

Lloyd's Register may well have acquired the information they published for British ships from the *Mercantile Navy List* and from published amendments to this work, as well as from their surveyors, agents or direct from the owners themselves.

Classification of steam collier owners

For all steam colliers in service during 1870 and during 1890, an attempt has been made to classify the trade or occupation of the major owner (Table 7.1). The stated occupation of those owning shares in the ships is taken either from details routinely supplied to local registrars and entered on the customs registers now held in the National Archives, and from the extensive collection of trade directories held in the Guildhall Library, London. Both must be treated with some caution. Trade directories often gave a variety of occupations for an individual or company; 'coal merchant' and 'shipowner' being descriptions which frequently occurred together, whilst shipbroker and shipowner are another common pairing. Although only one occupation per individual was allowed on the ship's registration form, this could change from one registration to another. Individuals undoubtedly had more than one interest, and a coal factor, say, who built up a substantial portfolio of shares in various colliers might have preferred to call himself by the, possibly more prestigious, title of ship owner, or may have considered shipping to have become his major business. Where the owners' self-description changed - as it does with John Fenwick, FD Lambert and FW Harris - the earliest description has been applied. The term shipowner has also been used when it is clear that the owner was also operating ships beyond the coastal coal trade. Steam colliers at this date almost invariably had a number of owners, and so the ship's husband or the largest shareholder has been chosen as representative of these owners.

Table 7.1: Classification of owners of east coast colliers in service 1870 and 1890

The list includes all steamers identified as active in the east coast coal trade in these years. Major owners are classified by their descriptions on registration documents or their trade as listed in contemporary directories.

	1870			1890		
Type of owner	**No. (n=132)**	**%age**	**Rank**	**No. (n=269)**	**%age**	**Rank**
Coal industry	81	61%	1	126	47%	1
Shipping company /ship owner/agent/broker/carrier	39	30%	2	111	41%	2
Shipbuilder/repairer	9	7%	3	8	3%	3=
Miscellaneous	-	-	-	7	3%	3=
Unknown	3	2%		17	6%	-
Total	132	-	-	269	-	-

The data in table 7.1 show that in 1870 the steam colliers working on the East Coast were predominantly owned by individuals in the coal business, whether colliery owners, their agents, coal fitters, coal factors or coal merchants. Of the 132 screw colliers identified as running coastwise in that year, some 81 (61 per cent) were owned by such individuals. Of those in the coal industry, the largest single category of owners was coal factors - usually with offices in the Coal Exchange, London - with 37 colliers (28 per cent), followed in second place by coal owners, with 31 colliers (23 per cent). Owners predominantly interested in shipping - and this includes limited liability steamship companies, and individuals who describe themselves as shipowners, shipbrokers or agents for ships - had 30 per cent of the colliers. Of these, limited liability shipping companies owned 26 colliers (20 per cent of the total) with shipowners, brokers or agents - individuals whose sole or major business was operating ships - having just 13 colliers (10 per cent).

Twenty years on, the picture has changed. By 1890, the total number of colliers has doubled to 269. Significantly, those whose business is solely ships had increased the number they own almost threefold, from 39 to 111, and with 41 per cent of total collier ownership now closely rival the coal industry. The latter have increased their holding to 126 colliers, but the growth in the total number of colliers has meant their overall share has declined, from 61 per cent in 1870 to 47 per cent in 1890. Interestingly, the category 'shipping company' has dwindled away, and accounts for only eight colliers (3 per cent). The case of the shipping companies is explored separately.

The shipowners' importance is under-represented by this sample, as important owners such as the Fenwicks have been classed as 'coal factors' because this was their description in 1870, although by 1890 Fenwick is describing himself as a shipowner. This tendency over time for coal factors to describe themselves as shipowners has been noted, and in fact the Fenwicks were to become part of one of the biggest owners dedicated to the screw collier, Wm. France, Fenwick and

Co. Ltd., set up in 1896. Classifying under 'shipowners' ships belonging to those classified as 'coal factors' in 1870 but who later became, first and foremost shipowners - the Fenwicks, Lambert, Harris and Dixon, Stephenson Clark - increases the total owned by shipowners in 1890 to 164 ships (61 per cent of the total), and reduces coal industry ownership to 73 ships (27 per cent of the total). Thus, the shipowner group is predominant.

Other authors have noted the shift in ownership away from the coal business to dedicated shipowners. Considering the steam colliers of Sunderland and Seaham, Macrae and Waine reckon that more than half of the 60 or so ships registered in 1870 were directly owned or controlled by the large collier proprietors.[5] They note that the five main coal-owning families were: Londonderry, Lambton (Joicey took over Lambton in 1896), Woods of Hetton, and Wearmouth Coal Company (associated with Fenwick, Stobart) and William Bell. After 1870, however, they discern that other owners not so closely connected with coal production begin to appear. This may represent the rise of the professional steam shipowner, a phenomena noted by Ville for sailing ship owners (also in the coal trade) during the period of his study of the Henley family, 1770 to 1830.[6]

5. Macrae, J.A. and Waine, C.V., *The Steam Collier Fleets* (Albrighton, 1990), page 41.
6. Ville, S., *English Shipowning during the Industrial Revolution: Michael Henley and Son, London shipowners 1770-1830* (Manchester 1987).

Classification of owners of west coast bulk carriers

An analysis has been made along similar lines to that above of the ownership of West Coast bulk carriers in 1870 and 1890 (table 7.2). For 1870, the numbers are very small (just 22 ships have been identified trading in the year), and a number of distinct trades are represented. The numbers are too small for reliable analysis, but do point to the relatively low importance of individuals in the coal trade as owners of bulk carriers: they rank third, below those in stone or metal extracting/refining and those in shipping. West coast ships are carrying iron ore from Cumbria to South Wales, moving stone from quarries, serving the iron, lead and copper refining industries, as well as carrying coal along the coast, across the Bristol Channel, and across the Irish Sea.

The 1890 figures for the ownership of the 228 west coast-owned steamers provide an interesting contrast with the east coast pattern (figure 7.1). By far the largest group of owners on the west coast in 1890, accounting for two thirds of ships in operation, declare their main interest to be in shipping, including those describing themselves as shipowners, shipbrokers, agents, and carriers. The category miscellaneous - including persons involved in extractive, refining or manufacturing industries - ranks higher than those in the coal trade (17 per cent vs 11 per cent).

Table 7.2: Classification of owners of west coast bulk carriers in service 1870 and 1890

The list includes all steamers identified as active in the west coast bulk trades in these years. Major owners are classified by their descriptions on registration documents or their trade as listed in contemporary directories.

	1870			1890		
Type of owner	**No. (n=22)**	**%age**	**Rank**	**No. (n=228)**	**%age**	**Rank**
Coal industry	4	18%	3	26	11%	3
Shipping company /ship owner/agent/broker/carrier	5	23%	2	151	66%	1
Shipbuilder/repairer	3	14%	4	6	3%	4
Miscellaneous*	6	27%	1	38	17%	2
Unknown	4	18%		7	3%	

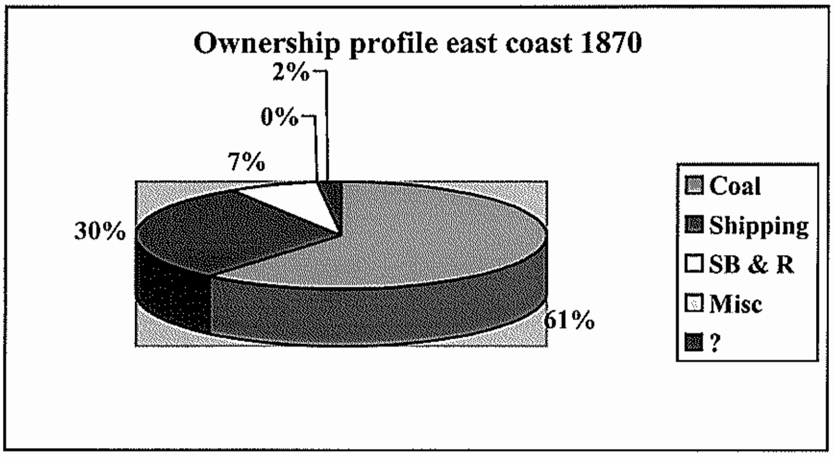
*In 1870, the miscellaneous category included four ships owned by persons involved in the extraction or refining of metals (iron, copper or lead) and two in quarrying. In 1890, there were ten owned by persons involved in quarrying, nine in extracting metals (all iron ore), four in explosives, four millers, two thread manufacturers, two master mariners, six described just as merchants, and one described as a 'gentleman'.

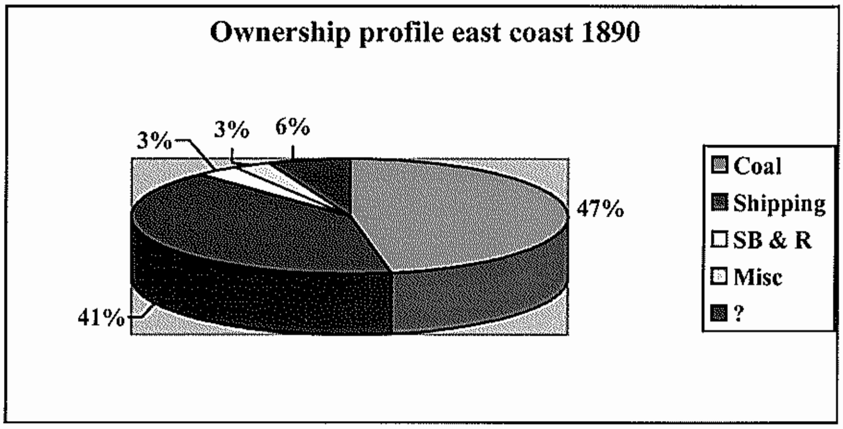
On the west coast, those in the coal business account for only a modest proportion of the total owners of bulk carriers in 1890: 11 per cent, lower than the total of other owners whose predominant interest is in industries other than shipping or coal.

Implications of the differences in ownership patterns between the coasts

The considerable difference in ownership profile between the east and west coasts in 1890 is clear from figure 7.1. Those primarily interested in shipping dominate ownership on the west coast and non-coal industry interests are in second place, with coal interests a poor third. On the east coast, coal industry interests have a clear margin over shipping interests whilst other industries are not significant owners.

The implication is that, in the early years of steam bulk carriers (say 1852 to 1880) most of those who sought to make a living primarily from shipping shunned these vessels. Funding screw colliers fell largely to the coal owners, whose wider business needs may have been best met by owning steamers to carry their coal. After 1870, and increasingly after 1880 (see figures in chapter 5), those in shipping became interested in bulk carrying steamers, to the extent that, by 1890, a majority of those working on the west coast (by then almost equal in numbers if not in size to those on the east coast) were in the hands of shipowners, and on the east coast ownership by shipping interests was increasing more rapidly than ownership by coal interests.





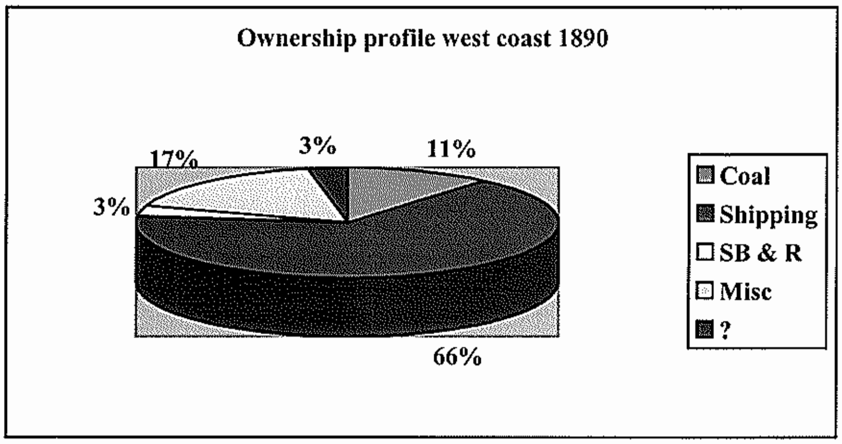


Figure 7.1: Ownership profiles for bulk carrying steamers 1870 and 1890

Note: west coast figures for 1870 are too small to be significant.

The fortunes of limited liability screw collier companies

A number of limited liability companies were registered in the 1850s and 1860s to own steam colliers. These companies were often set up by coal interests, but their share ownership went well beyond the coal industry. The companies' raison d'être was to make profits in order to pay dividends to their investors. Therefore, they can stand in contrast to the shipowning activities of coal industry individuals, for whom running ships at a profit may not have been the sole concern. The fortunes of the limited liability companies as revealed by their surviving records may therefore offer some insight into the profitability of owning colliers.

Limited liability companies were required to file certain details, including memoranda of association, lists of initial subscribers, details of directors, location of offices, lists of investors, amount of capital subscribed, and details of any changes in financial situation, including increase or reduction of capital, details of liquidation, and annual balance sheets.[7] These details were sent to the Registrar of Companies, and many company files compiled by this Government department during the nineteenth and earlier part of the twentieth century have survived in class BT31 at the National Archives. The annual returns have been heavily weeded, so that the files as they survive contain returns of capital subscribed and shareholders at roughly five-yearly intervals.

7. Armstrong, J. and Jones, S., *Business Documents: their Origins, Sources and Uses in Historical Research* (London, 1987).

The BT31 files yield little information on the day-to-day operation of a company, and all too often its financial fortunes are also somewhat obscure. Only very occasionally have any annual reports to shareholders and balance sheets survived. Alterations in capital are made with no explanation, and usually no reason is given why a company is liquidated, unless it is bankrupt. Neither is it apparent how the capital has been used, unless a balance sheet is found. The fortunes of the company must therefore be plotted from the aims set out in its memorandum of association (and these aims were typically set very wide), the occupations of its subscribers, its success in attracting capital, its longevity and eventual fate.

A certain amount of further information is available from shipping newspapers. The short-lived *Mitchell's Steam-Shipping Journal*[8] reported the half-yearly meetings of the General Iron Screw Collier Company Ltd. for a few years and occasional references to this company and to colliers in general are found in its editorials.

General Iron Screw Collier Co. Ltd.[9].

The General Iron Screw Collier Co. Ltd. is believed to be the first limited liability joint stock company set up to operate steam colliers. Indeed, it was one of the first joint stock companies to own ships. It was provisionally registered on 19th March

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8. Published weekly from August 1859 to 1869, *Mitchell's Steam-Shipping Journal* was an offshoot of the *Shipping and Mercantile Gazette*, also published by Mitchell. It is short on opinion and comment, and long on readily-available copy such as reports of mishaps and enquiries, circulars from shipbrokers, and patent applications.
9. National Archives BT31/172/519.

1852, but the registration process was not completed until 14th September 1852. The company's first stated aim was to build, purchase and own iron steam vessels with the screw propellor for the transfer of coals and other merchandise from port to port. Initially, nominal capital was £250,000 in 50,000 shares priced at £5 each but, when the company was at last registered, this had been increased to £400,000. By September 1852, almost £93,000 had been allotted. The share price of £5 was modest and possibly intended to attract small investors

The initial subscribers - i.e. signatories to the memoranda of association - were a mix of 'gentlemen' and businessmen. Amongst the latter were coal merchant William Cory, coal owner Matthew Hutton Chaytor, and Charles Mark Palmer, who described himself as a coal owner but was already a shipbuilder. Macrae and Waine claim that two of the directors were associated with gas companies, William Prinsep of the London Gas Company and Thomas Miers of the Commercial Gas Company.[10]

The General Iron Screw Collier Co. Ltd. owned the following colliers:

Name	**Delivered**	**Fate**
William Hutt	3.1853	Lost 11.1864
Countess of Strathmore	5.1853	Lost 7.1853
Northumberland	6.1853	Sold 1864
Sir John Easthope	7.1853	Missing 1863
Durham	8.1853	Lost 11.1857

10. Macrae, J.A. and Waine, C.V., page 15.

Jarrow	11.1853	Lost 10.1867
Marley Hill	2.1854	Sold 1863
Ross D. Mangles	5.1854	Lost 1866
Nicholas Wood	6.1854	Missing 1861
Black Prince	8.1854	Sank off Lisbon 1860
Firefly	9.1854	Wrecked Cape St Vincent 1867
Derwent	4.1855	Wrecked on South Uist 1865
Hutton Chaytor	6.1855	Sold 1881.
Eupatoria	1856	Wrecked Flamboro' 8.1857
Brunette	1861	Sold 1871
Blonde	12.1863	Sold foreign 1872
May Queen	1864	Sank in collision 1878
Lady Derby	1865	Wrecked 1877
Cromwell	1865	Missing 1878
Fairfax	6.1865	Wrecked 1881
J.E. McConnell	1867	Sold 1880
Dromedary	1869	Foundered 1873
H.P. Stephenson	1872	Sold 1881

The first nine vessels delivered in 1853 and 1854 were built at Palmer's yard at Jarrow, most certainly influenced by Palmer's association with the company. The author has argued that, had there not been a delay in registering the company, it might also have been the owner of the very first screw collier, *John*

Bowes delivered in June 1852.[11] Balance sheets for 1853 and some subsequent years up to 1856 have survived. The cost of each new collier was around £8,150, although the insurers paid out £9,000 on the loss of the two-month old *Countess of Strathmore*. The amount expended on vessels to June 1854 is recorded as just over £100,000, with a further £26,700 spent to June 1855, and £14,800 to June 1856. These figures can be compared with the known size and estimated cost of the fleet; the ten ships delivered to June 1854 would have cost between £80,000 and £90,000 with a further £8,000 to £9,000 for *Black Prince* in August and similar expenditure on *Derwent* in 1855. The cost figures include repairs to the vessels, which resulted in overall repair costs for that year being £13,229.

Receipts from freights are recorded only for 1854, when £33,135 is earned from 'outward freights for colliers' and a massive £64,913 'from transports'. The latter figure reflects the Government charter of a number of the company's colliers to take material for the Crimean War to Constantinople and the Black Sea. A dividend of £34,837 was paid in December 1854. The only other dividend reported in surviving BT31 papers is £15,126 in 1856, following a reduction in capital. Fortunately, however, *Mitchell's Steam-Shipping Journal* took an interest in the company for a few years, and reported it paying a dividend of 15 per cent in 1859,[12] 12½ in February 1860,[13] 10 per cent in August 1860,[14] 10 per cent on 11th

11. Fenton, R.S. 'John Bowes: the first bulk carrier?' *Ships in Focus Record*, No 20, 2002, 252-260.
12. *Mitchell's Steam-Shipping Journal* 19th August 1859, page 4.
13. *Mitchell's Steam-Shipping Journal* 10th February 1860, page 87.
14. *Mitchell's Steam-Shipping Journal* 10th August 1860, page 506.

February 1862.[15] It is clear from the report in this journal in 1859 that these apparently good figures were obtained by making no allowance for deterioration of the steamers or for contingencies. Of contingencies there certainly were many, and the August 1859 report suggested the company was involved in much litigation. In August 1860, Morrison, one of the most vocal opponents of the directors intimated that without allowance for depreciation and contingencies a satisfactory dividend needed to be 25 per cent.[16]

The company's nominal capital fluctuated considerably over its life. In May 1856 it was reduced from £400,000 to £125,000, said to be in 5,000 shares of £25 each. By 1861 it had been further reduced to £80,000, each share now being worth £16. In 1864, however, 2,500 new shares were issued at £16 to raise a further £40,000. This coincided with the beginning of the expansion of the fleet in 1864; lack of provision for depreciation clearly necessitated raising extra capital for fleet replacement. In 1868 capital was once again reduced.

There were attempts to find profitable trades for the steamers beyond the coastal coal trade. According to *Mitchell's Steam-Shipping Journal* in 1859 'It is said that the fleet of the Iron Screw Collier Co. (sic) which has recently been sold, will be withdrawn from the Italian trade and once more employed in the coal trade.'[17] The sale quickly fell through, but crew agreements provide ample evidence of the colliers running to Italy. *Ross D. Mangles* spent half of her time in

15. *Mitchell's Steam-Shipping Journal* 14th February 1862, page 101.
16. *Mitchell's Steam-Shipping Journal* 10th August 1860, page 506.
17. *Mitchell's Steam-Shipping Journal* 9th December 1859.

the trade in 1859; *Marley Hill, Nicholas Wood* and *William Hutt* were almost totally employed in Mediterranean and Baltic voyages that year; *Jarrow* made five Mediterranean voyages in 1858.[18] However, the fleet was by no means totally employed in these trades in 1859 and spent 30-40 per cent of its time carrying coal on the coast. Other vessels were employed as cable layers, *William Hutt* working in this capacity between Ostend and Dover in 1853. In 1857, *Durham* made a voyage to Sierra Leone, and in 1861 the newly-delivered *Brunette* sailed to Bermuda with Government stores. This activity strongly suggests that it was insufficiently profitable for the colliers to be totally employed in the east coast coal trade.

The desire to deviate from its original intentions in order to achieve greater profits seems the result of shareholder dissatisfaction. It is clear from a later half-yearly meeting in August 1859 that it had previously been resolved to sell the company's assets, or as it was put 'to dispose of the property of the company consistently with the interests of the shareholders.'[19] However, despite the directors' efforts no adequate offer had been made for any of the vessels. An adequate offer for a vessel, it emerged, was considered as £5,500. Later that year, William Cory and others made an offer of £60,000 for the company's existing fleet, which the directors recommended that the shareholders accept.[20] Their argument was a telling one: the company had made money with Government

18. Crew agreements in class BT98 at the National Archives. See appendix 2 for details of individual screw colliers.
19. *Mitchell's Steam-Shipping Journal* 19th August 1859, page 4.
20. *Mitchell's Steam-Shipping Journal* 23rd December 1859. page 300.

patronage during the Crimean war, but after the ending of the war they were not likely to make money competing with individual owners. The offer meant winding up the company, but the necessary three quarters majority to do so was not forthcoming.

Mitchell's Steam-Shipping Journal lost interest in the company after 1860, and papers in the BT31 file become sparse. A meeting in November 1878 resolved to wind up the company, but no reason was given in surviving documents in the BT31 file. Winding up was not achieved quickly, and when the collier *Fairfax* was lost in February 1881 she was still registered in the ownership of the company. Its ship owning came to an end only with the sale of *Hutton Chaytor* in March 1881.

The overall impression of the General Iron Screw Collier Co. Ltd. is of a company unable to produce sufficient earnings from its intended trade to feed the demands of its shareholders and to allow for depreciation and contingencies. It survived for several years through government patronage, then accepted that it could not compete with individual shipowners, but its owners were unable to agree on offers for its assets and it staggered on, largely unregarded, for two further decades. As Craig puts it, the company '...began with a bang but expired with a whimper.'[21] It was not a good advertisement for the profitability of the screw collier.

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21. Craig, R., 'Aspects of tramp shipping and ownership' in K. Matthews and G. Panting (eds.), *Ships and Shipbuilding in the North Atlantic Region* (St. John's, Newfoundland, 1978), page 215.

London Steam Navigation Co. Ltd.[22]

Registered in March 1864 at 44 Coal Exchange, London, this company's memorandum of association included as its first stated aim the acquisition of screw or other steam vessels to carry passengers and goods in all parts of Great Britain and Ireland as well as foreign. It had the massive nominal capital of £250,000 in 2,500 £100 shares. The price of a share - perhaps £2,500 at today's values - put share ownership well beyond the reach of small investors, and was probably aimed at limiting ownership to the subscribers and their associates. The company's initial subscribers were successful businessmen, including shipbrokers (the Pickernells), shipowner and coal factor John Fenwick, Charles Palmer the coal owner and shipbuilder (and builder of most of the company's ships), a solicitor, and two insurance brokers. Amongst the 53 individuals who had bought shares by May 1865 there were at least six prominent coal factors or coal owners, including Lambert, the Strakers, and the Hills of London and Southampton.

A total of £113,600 had been subscribed by May 1865, but perhaps this was not sufficient for its ambitious plans, as on 21st December 1866 came confirmation of a special resolution to wind up the company voluntarily. £134,000 shares were sold to the London Steamship Co. Ltd. (q.v.).

22. National Archives BT31/916/1069c.

London Steamship Co. Ltd.[23]

This company was registered in November 1866, in order a) to acquire the business of the London Steam Navigation Co. Ltd., b) to purchase, charter, hire screw or other steam vessels, and c) to sell coals or other goods and cargo. Capital was slightly less ambitious than its forerunner, at £200,000 in 10,000 shares of £20. Initial subscribers are largely those of its predecessor. The lower individual price per share, £20 compared with the £50 of its forerunner, suggests that £50 had been too high: there seems little reason otherwise to go to the trouble of winding up one company and starting another. By 1868, £130,000 had been subscribed, by shareholders of whom about 40 per cent were involved in the coal trade. Paid up capital slowly increased to £180,000 in early 1878. In March 1883 it was decided to voluntary wind up the company, but with the ships transferred to a new concern to be formed for the purpose. This was the London Steam Shipping Co. Ltd.

By 1880, the London Steamship Co. Ltd. owned 13 colliers, all relatively large vessels quite suitable for the foreign trade. The smallest was *Europa* built 1862 by Palmers with a gross tonnage of 666, and 207 feet in length, and the largest *Miranda*, built by Palmers in 1865 of 954gt and 211 feet in length.

London Steam Shipping Co. Ltd.

Registered in April 1883, the London Steam Shipping Co. Ltd. had the objective of purchasing the assets of the London Steamship Co. Ltd., its debts and liabilities,

23. National Archives BT31/1305/3344.

for £22,000.[24] Its nominal capital was £100,000 in 5,000 shares of £20, of which £64,000 was paid up. Holders of fully-paid up £20 shares in its predecessor received two shares in the new company for every five in the old, so their investment was being reduced to 40 per cent of its previous value. Richard Cory, of coal merchants William Cory, was now a shareholder.

The London Steam Shipping Co. Ltd. was voluntarily wound up in May 1885, just over two years after its formation.

Names, dates and fates of vessels owned by the London Steam Navigation Co. Ltd and its successors are listed below.

Name	**Built**	**Fate**
Italia	1860	Sold 1886 to Italy
Minerva	1861	Sold 1883, general cargo trade, Dublin
Europa	1862	Sold 1883, general cargo trade
Justitia	1862	Sold 1885 to Venezuela
Aurora	1863	Sold 1886 to Italy
Latona	1863	Goes 1876
Adria	1864	Sold 1885 to Fenwicks and others
Medora	1864	Sold 1885 to Fenwicks and others
Venetia	1864	Sunk in collision 1884
Miranda	1865	Sold 1885 to Fenwicks and others
Sabrina	1865	Sold 1885 to Fenwicks and others

24. National Archives BT31/3143/18154.

Statira	1865	Sold 1885, general cargo trade
Camilla	1866	Sold 1885 to Fenwicks and others
Palmyra	1866	Sold 1885 to Fenwicks and others
Oriana	1867	Wrecked 1877
Roxana	1868	Sold 1885 to Fenwicks and others

Only two of the 16 ships were lost during their lives with the companies. Neither of these was replaced, however, and after the *Roxana* was completed in 1868, no further ships were acquired. On winding up of the final company, the London Steam Shipping Co. Ltd., seven of its remaining 13 ships passed to John Fenwick and associates, five others going into general cargo trades for Dublin, London, Italian and Venezuelan owners.

The three successive 'London' companies succeeded in lasting for 21 years, outliving the General Iron Screw Collier Co. Ltd., and their relative longevity can be counted as an achievement of sorts. However, the companies appear not to have passed the test of any successful commercial enterprise, in that they failed to generate (or perhaps retain) sufficient profits to replace their major assets, the steam colliers; none being acquired after 1868 despite two losses. That lack of earnings was more the problem than, say, disagreement amongst its shareholders is suggested by the 1883 reformation, where shares were, effectively, devalued by 60 per cent. Neither were the assets worn out: most of the colliers owned had useful lives after the 1885 liquidation.

Southampton Steam Collier and Coal Co. Ltd., Southampton[25]

Registered in Southampton in March 1865, the memorandum of association for this company included as its first stated aim, 'Purchase and sale of coal, conveyance of passengers and goods in ships and boats...' Its nominal capital was £60,000 in 3,000 £20 shares. Initial subscribers included various business people at Southampton, including a coal merchant (Robert Ekley) and another described merely as a merchant, and the Thames shipbuilders George and Peter Lungley. Coal merchant Robert Ekley was the initial owner of the collier *Basingstoke*, launched in September 1865. Those who bought shares were mainly resident in Southampton, and there does not seem to have been any particular concentration of shares in the hands of those involved in the coal trade, although London coal factors (they were also shipowners) Dixon and Harris are listed. Within nine months of the company's flotation, 1,090 shares had been paid up at a rate which yielded £12,220. By 1870, £36,140 had been subscribed, in 1,786 shares - this amount exceeding the company's original nominal capital. In September 1874 a meeting of the company resolved that it should be wound up, although no reason is given in the papers which survive in BT31.

The ships owned were:[26]

Basingstoke 1865/649gt. Sold in 1874 to Spain

Salisbury 1866/635gt. Sold 1874 to Hull owners.

25. National Archives BT31/1069/1936c.
26. According to *Lloyd's Registers* and *Liverpool Underwriters' Registers* for 1870.

Southampton 1865/610gt. Wrecked off Spain 1872

With contemporary shipbuilding costs, building a fleet of three or even four colliers would be consistent with the nominal capital of £36,000 (*John Bowes* is reported to have cost £10,000 in 1854).

Here we have an adequately-capitalised company, which survived just nine years before going into voluntary liquidation. It is possible that the loss of *Southampton* in 1872 affected the company, but such losses were not unexpected (the loss rate of the General Screw Collier Co. Ltd. was high). It can only be assumed that, as in the case of the latter company, profits were not up to expectations and that in 1874 it was decided to sell the two remaining colliers and distribute the proceeds amongst the shareholders.

London Steam Collier and Coal Co. Ltd.[27]

Registered May 1865 with a nominal capital of £300,000 in 30,000 £10 shares, the first stated aim of the London Steam Collier and Coal Co. Ltd. was 'The carrying, purchase, working and sale of coal and generally for the further development of the coal trade, annually and for that purpose to purchase, hire, or build screw steamers or other collier ships and to rent collieries, wharves or premises.' Of its initial subscribers, only William Green, coal merchant, was in the coal business, as were very few of those who bought shares. In general, its subscribers do not seem to have had much business experience. One of its articles insists that Green and

27. National Archives BT31/1106/2152c.

Sargeant of the Coal Exchange would be its coal brokers, but this article was expunged in 1866.

After over a year, in July 1866, just £24,483 of its capital had been subscribed. However, after its name changed to The Original Hartlepool Collieries Co. Ltd. in April 1868, the pace of subscription seems to have increased, and by May 1871, £169,890 had been called up. In 1875, it was resolved to raise an additional £50,000. Yet, in January 1877, it had been 'Proved to the satisfaction of the company that (it) cannot continue its business, and it is advisable to wind it up.'

Only the steam collier *Ludworth* (968gt, 170 feet long and built 1866) is known to have been owned by the company. Presumably, other monies went into mines, wharves and premises. The London Steam Collier and Coal Co. Ltd. and its successor appears to have been somewhat minor players amongst collier owners, and an explanation of its failure may lie in problems concerning the coal extraction side of its business rather than in the shipowning side.

Union Steam Collier Company

Although not a limited company, the experiences of the Union Steam Collier Company have been well documented.[28] Formed in September 1853, the company was originally known as the Southampton Steam Shipping Company, and was intended to ship Cardiff coal to Southampton for the use of steamers owned by the

28. Craig, R., 'Aspects of tramp shipping and ownership'; Newall, P., *Union-Castle Line: A Fleet History* (London, 1999).

Peninsular and Oriental Steam Navigation Company, with which shared director Arthur Anderson. Five screw colliers were ordered from yards on the Thames. Only the first collier actually went into service on the intended route, as the outbreak of the Crimean War meant the steamers for which the company was to supply coal were diverted to serving the military needs of this conflict. The colliers were then chartered to provide a service on P&O's routes to the eastern Mediterranean, and later became transports for the War Office, and later vessels were modified accordingly whilst building. When the Crimean War ended in 1856, it is said that the Union company's ships were unemployed, [29] although it has not been explained why they did not resume the Cardiff to Southampton sailings with coal for which they were designed. After an abortive attempt to use the colliers on a South American service in opposition to the Royal Mail Steam Packet Company, the company won a contract to carry mails to Cape Colony. In recognition of its changing role, the company was renamed the Union Steamship Co. Ltd. on adoption of limited liability status in 1856. Despite experienced and energetic management, and what was probably a captive market for its cargoes, this was yet another company which failed in its original intention of carrying coal in steamships.

Experience of the limited companies

The General Iron Screw Collier Co. Ltd. staggered from crisis to crisis, failing to make an adequate profit to meet depreciation, contingencies and dividends, taking

29. Newall, P., page 18.

its vessels out of the coal trade on several occasions, placing all its ships on the market on another, and drastically reducing its capitalisation. The Southampton company lasted just nine years, and the London Steam Collier and Coal Co. Ltd. in its original manifestation failed to raise its ambitious capital and, in its later guise, appears to have invested (unwisely) in collieries rather than in ships. The three 'London' companies with larger vessels survived for over 20 years with periodic reductions in their asset values, but ultimately failed in that they were unable to replace their assets. The Union Collier Company diverted its colliers to a different trade. It is concluded that, in the 1850s and 1860s, the ownership of coastal steam colliers by such joint-stock companies was not a profitable venture.

Contemporary press reports and opinion

Mitchell's Steam-Shipping Journal was published weekly from 1859 to 1869, an offshoot of Mitchell's *Shipping and Maritime Gazette.* Offering 'A weekly newspaper devoted to the interests of steam navigation', it by no means fulfils its promise to the researcher of being a likely source of incisive, well-informed comments on the trade of bulk-carrying steamers in this decade when east coast ownership was well ahead of west coast ownership.

Passing references are made to commercial crises, that of 1857 being felt badly by steamship owners, with building prices dropping from £18/ton to £10/ton.[30] In 1862, *Mitchell's Steam-Shipping Journal* reports that 'Steam navigation received such discouragement that it was almost impossible to raise

30. *Mitchell's Steam-Shipping Journal* 6th January 1860, page 4.

capital. Nearly every company not subsidised by a mail contract, and some that were, were dissolved.'[31] The year 1866 saw yet another financial collapse, and in 1867 'Enterprise was dead - no new shipping companies formed.'[32] In July 1865, the editor virtually repeats himself in recording that before 1864 'Nearly every company whose capital was subscribed, and which was not subsidised by the Post-office, for a series of years, ended in winding up, and even two of those that undertook postal contracts were dissolved, after entailing a heavy loss on the pockets of those who contributed to their promotion'.[33] This same editorial records the floating of the Liverpool and Dublin Steam Navigation Co. Ltd., with a proposed capital of £400,000 to run liner services between Liverpool and Dublin and to work colliers between the Mersey ports and Dublin. Despite being formed under the auspices of three railway companies, the Midland, the Great Northern and the Manchester, Sheffield and Lincolnshire Railway, this enterprise seems to have been stillborn, and receives no mention in various histories of the Liverpool to Dublin trade.[34]

Even allowing for the tendency of journalists to play up bad news, it seems that the 1860s were not propitious years for entrepreneurship in steam.

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31. *Mitchell's Steam-Shipping Journal* 1865, page 420.
32. *Mitchell's Steam-Shipping Journal* 1868, page 468.
33. *Mitchell's Steam-Shipping Journal* 7th July 1865, page 420.
34. McNeill, D.B., *Irish Passenger Steamship Services* (Volume 1 and Volume 2) (Newton Abbott, 1971); Sinclair, R.C., *Across the Irish Sea* (London, 1990).

Explaining ownership patterns

Five possibilities present themselves to explain the initial ownership of colliers largely by individuals in the coal business, with a gradual shift towards ownership by those whose major interest is shipping.

1. *With their closeness to the business, those mining, selling or trading in coal saw the profit opportunities of screw colliers before others and invested early. Shipowners took time to catch up.*

Screw colliers were not a closely-guarded secret; on the contrary, they were well promoted. Charles Palmer, the builder of *John Bowes*, was clearly aware of the value of publicity. The *Illustrated London News* featured *John Bowes* twice, once on her launch and again on her first successful voyage to the Thames a few weeks later[35]. Clearly, Palmer ensured that his collier was given favourable publicity to gain repeat orders for his shipyard. These orders he was very successful in winning, and they allowed him to greatly expand his shipbuilding business, not only enlarging his Jarrow yard but also enabling him to begin building at Howden. Other shipbuilders, notably James Laing at the Deptford Yard, Sunderland, soon decided that building iron screw steamers was a good business opportunity. Palmer was also involved in floating the General Iron Screw Collier Co. Ltd. and this suggests that he wanted more collier orders for his yard, and did not care where they came from. Even if the screw collier owners were reticent in admitting the success of their vessels, the builders had no scruples about

35. Fenton, R.S., 'John Bowes: the first bulk carrier?'

trumpeting the achievements of the colliers they built,[36] and they would leave potential owners in no doubt about the viability of the screw collier. There were several successful attempts to raise finance for screw collier companies which would have raised awareness of the potential profitability of this type of vessel. In some cases, these companies were promoted by established figures in the coal industry. It seems unlikely that non-coal industry investors were left in the dark as to the potential of screw colliers, and this possibility can be rejected.

2. *Those in the coal business had, or could raise, the capital required to finance screw colliers, whereas shipowners had more difficulty financing such vessels.*

There were several successful attempts to raise capital to finance steam colliers, and this capital came largely from outside the coal business. A number of well-capitalised shipping companies - the General Screw, the London Steamship Company, the Southampton Steam Collier and Coal Co. Ltd. - were floated with the express intention of buying and operating screw colliers and succeeded in raising substantial amounts of capital. Therefore, capital was certainly available to those outside the coal business who wished to build screw colliers, and this possibility can be laid aside.

36. For example, Allen, E.E., 'On the comparative cost of transit by steam and sailing colliers, and on the different methods of ballasting.' *Proceedings of the Institute of Civil Engineers* XIV (1854-5), 318-73.

3. *Those in the coal business recognised the profitability of screw colliers and combined to exclude 'outsiders', i.e. potential shipowners, from this lucrative area.*

Given the diverse nature of the coal trade, with collieries competing against each other to sell coal on the London market, and particularly to secure contracts with large users such as the gas companies, it is difficult to see such a combination operating. No mention of such a cabal has been found, not in the historiography of the coal factor business,[37] nor in that of the screw collier,[38] nor of the collier-owning companies,[39] nor in contemporary periodicals devoted to steam shipping.[40] Given the Victorian belief in the operation of free enterprise, it seems unlikely that shipowners excluded from a market in such a way would remain silent.

4. *Although not combining to exclude outsiders, the coal business made it very difficult for colliers owned by outsiders to unload efficiently.*

Cory and Lambert were coal merchants and coal factors respectively, who also owned steam colliers, and provided facilities for the their rapid discharge on the Thames. Cory adapted or built a number of pontoons, named *Atlas 1* to *Atlas 3*, which were moored in the Thames and could quickly discharge coal from colliers into lighters using their steam cranes. Lambert had facilities in one of the closed docks on the Thames. Presumably both owners could restrict access to steam colliers whose owners they disapproved of or wished to thwart. However,

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37. Smith, R., *Sea-coal for London: History of the Coal Factors in the London Market* (London, 1961)
38. Macrae, J.A. and Waine, C.V.
39. For example, Carter, C.J.M., *Stephenson Clarke* (Kendal, 1981) and Anonymous, *Wm. France, Fenwick and Company Limited* (London, 1954).
40. *Mitchell's Steam-Shipping Journal*, published between 1857 and 1869, has been scanned.

gas works were an important user of screw colliers and they were unlikely to be complicit in a collier owners' plan to restrict access to unfavoured colliers. There is no reason to believe that 'combinations' of coal interests acted in this way.

5. *The financial return on screw colliers up to at least 1870 is not sufficiently attractive to those who need to make their livelihood purely as shipowners. However, those winning or selling coal are less interested in profiting from a steamer than servicing their customers, and would subsidise screw colliers if it brought them an overall business advantage.*

Evidence that the large, limited liability companies floated to operate screw colliers in the 1850s and 1860s had mixed financial fortunes tends to suggest that screw colliers could not yet be relied on to be profitable. This would explain why individuals interested solely in shipowning, reliant on profits from their vessels to make a living, were at best only toying with screw colliers in the 1850s and 1860s. In contrast, the larger coal owners who had the resources to finance steamers would be interested in obtaining large contracts from gas companies and other industrial users, contracts which would help ensure their financial security and allow investment in their mines (evidence of this is presented in chapter 11). For the colliery or its agent the coal fitter, part of the price of securing a contract would be the cost of buying or hiring screw colliers to guarantee regular deliveries. Further evidence for the importance of deliveries to large undertakings such as gas works is the ownership by individuals in the gas industry of packets of shares in colliers. For the larger coal merchants, there would be advantages to their business in the relatively uninterrupted deliveries which the screw collier offered.

As the economics of the steamer improved, from the 1870s onwards, shipowners would become more interested in the screw collier, and by concentrating purely on working them profitably would have been able to do better financially than the coal owners, who had other concerns. Hence, the proportion of shipowners operating screw colliers grew after the 1870s at the expense of those in the coal trade.

Conclusion

From the patterns of ownership of screw colliers, and the fortunes of companies floated to operate them in the coastal trade, it is concluded that during the 1850s and 1860s these steamers were not sufficiently successful as individual profit earners to encourage investment by more than a few individuals who wished to make a living from shipowning alone. The screw colliers that were built in considerable numbers were predominantly financed by individuals in the coal trade: colliery owners, coal fitters, coal factors and coal merchants, with some help from those in the gas industry. Their concerns were less with earning a profit from the screw collier itself than with supporting their overall business through facilitating deliveries of coal regularly and relatively cheaply. They would tend to look at the economics of the overall operation rather than concerning themselves whether each collier voyage was intrinsically profitable. During these decades the screw collier was built more often to support the coal trade than to earn profits.

As steamships became more efficient, and their potential for profitable operation improved, those whose interest was in operating ships at a profit began to move more strongly into collier owning, a trend which is apparent on the east coast between 1870 and 1890. This also helps explain the very low ownership of bulk-carrying steamers on the west coast prior to 1870. With no large centres of the coal trade, as there were on the east coast, there were few powerful individuals in the coal trade with the resources to finance and run steamers. When ownership of steam bulk carriers did expand on the west coast, ownership was very largely in the hands of steamship owners rather than coal industry interests.

Some individuals whose interest was solely in shipowning did succeed in operating screw colliers during the pioneering decades to 1870, at least according to the criteria of prolonged ownership of the same vessel. Lack of evidence makes it difficult to know if charters of their steamers to coal or gas interests ensured that these owners made a living, or if they did so simply by using good management techniques. Whatever, it is clear that operating a screw collier profitably did not appeal as an easy option to most shipowners, and before 1870 they showed little interest in these ships.

CHAPTER EIGHT: THE SHIPPING BUSINESS AND STEAM

There were significant challenges to the aspiring steamship operator. A steamer was inherently much more expensive than a sailing vessel, so there was a greater requirement for capital. Ship owners' and ship managers' business operations may also have needed to change to operate steamships. It is expected that a more sophisticated shore-based operation was needed for vessels which needed to be kept running much more intensively than sailing ships if they were to meet their higher capital and running costs.[1]

This chapter considers whether developments in finance and management contributed to the expansion of the bulk carrier fleet by making it easier to acquire and run such ships. Also considered is whether there were differences in the adoption of these developments that may explain why west coast ports lagged behind the east coast in ownership of steamers for the coastal bulk trades.

Financing steam colliers and bulk carriers

Raising finance was a major problem for the steamship owner. A typical coastal bulk carrier of about 400 gross tons cost about £10,000, or £25 per gross ton.[2] According to Allen, between three and six sailing colliers each

1. For a detailed account of ownership of sailing ships in the period just prior to this study, see Ville, S., *English shipowning during the industrial revolution: Michael Henley and Son, London shipowners 1770-1830* (Manchester, 1987).
2. This is the price quoted for the pioneer screw collier, *John Bowes*, and the evidence discussed in chapter 10 suggests that the a steamer of the same size cost roughly the same in 1880.

carrying 300 tons could be built for this price.[3] How was the necessary capital raised?

Sources and methods

Questions regarding the capital requirements of steamships are addressed in part by examining the pattern of financing steamers over the period. Information on ownership appears in registration documents of ships (classes BT108 and 110) and data on the capitalisation and share ownership of limited companies in returns made to the Registrar of Companies, now in class BT31 at the National Archives.

There has been a limited discussion of ownership patterns and ship finance during the period in the academic literature, and this has been used where appropriate.

Actual business records of shipowners and managers are very sparse for this period. This is disappointing as three of the large early owners of colliers - Stephenson Clarke, William Fenwick and William Cory - progressed to become major shipowners, and histories of each have been published and two have left substantial archives.

Stephenson Clarke and Company dates from 1850, but the Clarke family had been shipowners in the east coast coal trade since at least 1730. Apart from noting that the company first operated screw colliers in 1865, the three published histories of the company offer few insights into the way this sailing

3. Allen, E.E., 'On the comparative cost of transit by steam and sailing colliers, and on the different methods of ballasting.' *Proceedings of the Institute of Civil Engineers* XIV (1854-5), page 320.

collier owner adapted to steamships,[4] although it is recorded that there was a strong association with gas companies.[5] Efforts to find any early documentation from the company have been unsuccessful. Some of the company's records have been deposited with Tyne and Wear Archive Service at Newcastle-upon-Tyne, but the catalogue does not list any items from before the twentieth century.[6]

The origin of the coal merchant business of William Cory has been dated to both 1785[7] and 1811.[8] William Cory was an early and important investor in steam colliers, first taking an interest in these vessels in 1854 with a shareholding in the large collier *Samuel Laing*.[9] He made a major contribution to the mechanisation of steam collier discharge, with hydraulic cranes being installed at his London wharf in 1855 and the use of mid-river pontoons from 1861. However, little is known of Cory's business methods.[10]

The third large collier owner, William France, Fenwick and Co. Ltd., was a 1901 amalgamation of three shipping companies. The company published privately an account of its history in 1954 but virtually nothing was

4. Carter, C.J.M., *Stephenson Clarke* (Kendal, 1981); Anonymous, *A Link with Tradition. The Story of Stephenson Clarke Shipping Limited 1730-1980.* (Published privately, London 1980); Middlemiss, N.L., *Black Diamond Fleets* (Gateshead, 2000), pages 31-50.
5. This is explored in chapter 11.
6. These records were probably deposited when Stephenson Clarke Shipping Ltd. was taken into new ownership, based at Newcastle-upon-Tyne, in 1992. Earlier records may exist: the archivists at Tyne and Wear admit that no more than 55 per cent of their holdings are catalogued.
7. Anonymous, *One Hundred Years of the Cory Fleet* (Kendal, circa 1961); Keenan, K.E., *The Fires of London* (Waldron, East Sussex, 1997).
8. Middlemiss, N.L., pages 14-30.
9. Appendix 2 includes details of known steam colliers, the primary source being registration documents.
10. Ownership of the Cory business ended up with the Liverpool-based Ocean Trading and Transport who, before they abandoned the transport business, deposited surviving records at the Maritime Museum in Liverpool. Again, the catalogue of this holding reveals no documents surviving from the period under investigation, although there is an unpublished history of William Cory.

known of its forebears.[11] William Fenwick and his family, in particular, had close links with collieries on the River Wear, and was also an early investor in steam colliers, sharing with the Corys and others an interest in the *Samuel Laing* of 1854. Fenwick's close involvement with Cory continued until 1896, when the fleet he then managed was one of a number merged into William Cory and Co. Ltd.

The most substantial history of a London coal merchant is that of Charringtons,[12] but this company had no colliers of its own until the twentieth century, and the history makes little mention of shipping.

With a dearth of documentation relating specifically to the major owners of steam colliers, considerations of management problems relies on more general discussions in the literature.

Financing steamships

The aspiring shipowner had four ways of raising the necessary capital for a steamship.[13]

The share system was the most common form of ship ownership by the mid-nineteenth century, and this was largely perpetuated for the steam bulk carriers. After 1854, the sole basis for division of the capital of the ship was

11. Anonymous, *Wm. France, Fenwick and Company Limited* (London, 1954).
12. Fraser-Stephen, E., *Two Centuries in the London Coal Trade: the Story of Charringtons* (London, 1952).
13. This is discussed in section 4 of Cottrell, P.L., 'The Steamship on the Mersey, 1815-80: Investment and Ownership.' In: Cottrell, P.L. and Aldcroft, D.H. eds. *Shipping, Trade and Commerce: Essays in memory of Ralph Davis*. (Leicester, 1981), pages 149-156.

into 64th shares.[14] The total value of the vessel was divided by 64, and shares of this value were sold to individuals, although one 64th share could be owned jointly by two people. Given the cost of a new steamer, a 64th share would cost around £150. This was probably beyond the means of the small investor, and probably beyond his or her willingness to take a risk, especially as he or she was financially liable for a proportion of running and repair costs, and any misadventures the vessel might suffer which were not covered by insurance. Thus, ownership of 64th shares in steamships was largely amongst those who had accumulated modest wealth.

Setting up an unincorporated company to own ships was made easier by the repeal of the Bubble Act in 1825, but was still surrounded by legal uncertainties. One of these uncertainties may have been the refusal of registrars of shipping to register shipping property under the title of an unregistered company. Certainly, no steam collier has been found which was registered in the ownership of such a company, although company titles such as the 'Ryhope Coal Company' are occasionally entered as owners in non-official documents.

A royal charter to set up a full corporation cost around £400, and could be opposed by competing interests. Although the General Steam Navigation Company took this route in 1847, no steam collier or bulk carrier companies followed their lead, probably because cheaper alternatives were becoming available.

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14. Boyce, G., '64thers, syndicates, and stock promotions: information flows and fund-raising techniques of British shipowners before 1914' *Journal of Economic History* LXIV, 1992, footnote to page 183.

Ownership by a limited liability joint stock company was possible after 1844, and legislation introduced between 1856 and 1862 made this form of ownership progressively simpler and more straightforward.[15] As well as the limit of liability to the value of the issued capital, an advantage was that, as there was no limit to the number of shares, sufficient could be issued to make the price of an individual share low enough to appeal to small investors. For instance, the General Iron Screw Collier Co. Ltd. issued shares at £5 each.[16] The disadvantages were mainly administrative: annual accounts and lists of directors and shareholders had to be furnished to the Registrar of Companies. However, the alternative, the 64th share system, also imposed administrative burdens: each transaction (which could involve only one share) had to be registered and if the managing owner wanted to sell the ship he had to obtain the agreement of all the shareholders.

Initially at least, London owners seemed more ready to adopt limited liability than those elsewhere. Palmer found that 217 out of 334 steam vessels registered at London in 1852 were in the names of joint stock companies,[17] whereas Cottrell found only 19 out of 92 Liverpool steamers registered this way in 1851.[18] Cottrell dates the widespread adoption of limited liability status for

15. Introduction to Armstrong, J. and Jones, S., *Business Documents: their Origins, Sources and Uses in Historical Research* (London, 1987), pages 1-19.
16. National Archives BT31/172/519.
17. Palmer, S., 'Investors in London shipping 1820-1850' *Maritime History*, II, 1972.
18. Cottrell, P.L. gives his source as Parliamentary Papers 1851, LII; 'A return of the whole of the Registered Steam Vessels of the UK on 1st January 1851.'

shipping companies to the 1860s and the 1870s.[19] Many of the registrations in the 1870s were of single-ship companies, where the liability of an enterprise was limited to the value of the ship it had purchased. Cottrell found that this became the predominant form of ownership in Liverpool, Cardiff and in the north east ports.

Data in Appendix 2 indicates that ownership of steam colliers and bulk carriers was largely on the 64th share system,[20] with a modest trend over time towards ownership by limited liability companies. The first example found of ownership of steam colliers by a limited liability company was the General Iron Screw Collier Co. Ltd., registered in 1852 (see Chapter 7). Over its existence this company owned 23 ships, the last delivered in 1872. The London Steam Navigation Co. Ltd., registered in March 1864, was replaced in 1866 by the London Steamship Co. Ltd., which lasted until 1883 when it in turn was replaced by the London Steam Shipping Co. Ltd. The fleet had 15 screw colliers by 1871, all relatively large vessels over 200 feet in length and probably intended for European rather than coastal trading.[21] Smaller concerns were the Southampton Steam Collier and Coal Co. Ltd. with three steamers and the London Steam Collier and Coal Co. Ltd., with just one. Both smaller

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19. Cottrell, P.L., 'The steamship on the Mersey, 1815-80: investment and ownership' in Cottrell, P.L. and Aldcroft D.H. (eds.), *Shipping, Trade and Commerce: Essays in Memory of Ralph Davis* (Leicester, 1981), page 150.

20. Craig agrees, suggesting that owners of screw colliers on the 64th share system were more successful than those owning vessels through limited liability companies. Craig, R. 'Aspects of tramp shipping and organisation' in Craig, R., *British Tramp Shipping 1750-1914* (Research in Maritime History No. 24) (St. John's, Newfoundland, 2003), page 26.

21. This year was chosen as it saw publication of the first edition of the *Mercantile Navy List* which separated steam and sail. The *Mercantile Navy List* recorded all vessels in service at the end of December 1870.

companies were registered in 1865. Thus, by 1872 a total of 44 steam colliers had been owned by limited liability companies, about one quarter of the total fleet.[22]

The account in Chapter 7 of the misfortunes of the General Iron Screw Collier Co. Ltd. suggests that it was not a model other owners would wish to emulate: as Craig puts it, the company '...began with a bang but expired with a whimper.'[23] Neither this company, nor the London Steam Navigation Co. Ltd. and its successors passed the test of a viable shipping company in that they appeared unable to finance the replacement of their ships as they aged. Thus, although a significant number of screw colliers were owned by them up to the 1870s, limited liability companies were singularly unsuccessful in owning bulk carriers.

Craig compares the joint stock companies with the more enduring steam collier enterprises formed by men financially linked to the coal industry and who owned ships on the 64th system.[24] He attributes the joint stock undertakings' lack of success to their being managed by businessmen without close links to the coal trade. However, this must be questioned given that both the General Iron Screw Collier Co. Ltd. and the various London shipping companies were formed and managed by men intimately involved in the coal industry, such as Charles Palmer and John Fenwick.

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22. Figures in chapters 4 and 5 show the total number of colliers in operation during 1870 was 138, but a number had been lost by 1870.
23. Craig, R., 'Aspects of tramp shipping and organisation', page 24.
24. Craig, R., page 26.

On the west coast up to the 1870s, just six coastal bulk carriers have been found which were owned by limited liability companies (table 8.1).

Table 8.1: Coastal bulk carriers operating on the west coast owned by limited liability companies

Data from the ships' histories in Appendix 2

Name	Date	Owner	Founders
Vanderbyl	1864	Lundy Granite Co. Ltd.	Not known
Kirkless	1865	Kirkless Hall Steam Navigation Co. Ltd. (later)	Lancashire coal owners and iron masters, later Wigan Coal and Iron Co. Ltd.
Preston Belle	1865	United Kingdom Screw Collier Co. Ltd.	Dublin-based coal merchants
Isabella Croll	1865	United Kingdom Screw Collier Co. Ltd.	Dublin-based coal merchants
Dublin	1866	United Kingdom Screw Collier Co. Ltd.	Dublin-based coal merchants
Liffey	1870	Welsh Coal and Mineral Oil Co. Ltd	Liverpool-based owners of collieries in North Wales

A total of around 50 coastal bulk carriers owned in west coast ports have been identified up to 1871,[25] so 10 per cent were in the hands of limited liability companies, a lower proportion than on the east coast. The 1870s saw even fewer steam bulk carriers on either coast being registered to such companies; only four have been found on the west coast and none on the east coast.

However, in the 1880s Liverpool owners in particular embraced the single-ship, limited liability company. A total of 17 such companies have been identified, set up by six owners to finance coaster building: the Mack family

25. Table 5 in Chapter 4 identifies 37 bulk carriers in service on the west coast. The estimated figure of 50 is cumulative, and includes vessels lost and - more importantly - transferred away from west coast bulk trades.

(seven ships/companies); Hume, Smith and Co. (four ships/companies); Richard Hughes (three ships/companies), and three each by other owners.[26] A notable omission from this list is the most successful of all west coast bulk carrier owners, William Robertson of Glasgow, who financed the largest fleet without floating a single-ship or any other limited liability company.[27] Limited liability was thus a useful, but by no means essential, condition for financing a fleet of steam bulk carriers and nor did it guarantee success.

The capital market or ownership networks?

It is possible that a shipowner based in London was better placed to raise finance because of his ready access to the mature capital market in the city. This might have made it easier for him to build steamers than his west coast-based contemporaries.

Examination of the database of steam bulk carriers (Appendix Two) reveals that the predominant form of ownership of screw colliers and of the relatively few early bulk carriers on the west coast was by 64th shares. Amongst screw colliers the same names recur in lists of share owners, and - as was shown in Chapter 7 - they often had closely related occupations, such as colliery owner, coal factor, coal merchant. This supports Boyce's analysis of

26. Fenton, R.S., *Mersey Rovers* (Gravesend, 1997).
27. Unpublished work by the author, drawing on ownership details in various editions of *Lloyd's Register*, the *Mercantile Navy List*, *Lloyd's Confidential Index*, and classes BT107 to BT110 in the National Archives. One of the mysteries concerning Robertson is how he, originally a coal merchant, financed his fleet: the registration documents indicate he personally owned 64 shares in most of his ships, and very few mortgages are recorded.

fund raising techniques of British shipowners.[28] He found that shipowners both in the liner and tramp sectors of deep-sea shipping depended primarily on private networks to fund their ventures. Business associates, as well as family members, would be approached to secure capital, forming networks that were bound together by reputation and exchange of information. This system ensured that the promoters kept control of the fleet, and that confidential information of importance to the business would not be spread widely. The colliery owners, coal factors and merchants who largely financed screw colliers were already working closely together and were interdependent: they formed a natural network amongst which finance could be arranged. Boyce observes that shipowners used 'outside' capital, raised through public share issues, only to supplement private resources. This is apparent in screw collier ownership where only relatively isolated cases of publicly-financed limited liability companies are seen. Of his sample of major shipowners, Boyce concludes that '...neither London finance nor the capital market played a major role in enabling entry. The main impetus behind new ventures was private local capital.'

Given the ability to raise money through private networks - which extended well beyond London - the London capital market was not a factor in the ability of a potential owner of a steam bulk carrier to raise finance.

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28. Boyce, G., '64thers, syndicates, and stock promotions: information flows and fund-raising techniques of British shipowners before 1914' *Journal of Economic History* LXIV, 1992, pages 181-190.

The advantages of a large fleet were recognised in the east coast coal trade, which saw several mergers of shipping interests in the late 1890s and early 1900s. This began in 1893 with the merger of the London shipowners and coal factors the Fenwicks, with Wearmouth coal owners William Stobart to form Fenwick, Stobart and Co. Ltd.[29] Perhaps feeling threatened by this, the Cory family in turn participated in an 1896 merger which included Lambert Brothers, J. and C. Green, and Green, Holland and Sons and resulted in William Cory and Sons Ltd. capitalised at £2,000,000.[30] In 1901 Fenwick, Stobart and Co. Ltd. further merged with Leeds shipowner William France and Co. Ltd. and London ship manager Herbert Pelly and Co. to form William France, Fenwick and Co. Ltd.[31]

These mergers were a parallel development to the groupings in deep-sea shipping which began in the 1890s and saw owners such as Ellerman, Furness, Phillips (Lord Kylsant) and others control large fleets. Boyce has described this phenomenon,[32] and explains it in terms of two distinct periods for British shipping. Between 1840 and 1890, rapid technological progress and rising global trade offered shipowners a growing range of opportunities to tap. After 1890, steam ship services were well established and technical progress was slower, offering fewer opportunities to shipowners and hence encouraging mergers to provide economies of scale. In support of Boyce's observations, by the time of the 1893 to 1901 mergers amongst collier operators, the screw

29. Macrae, J.A. and Waine, C.V., *The Steam Collier Fleets* (Albrighton, 1990), page 53.
30. Macrae, J.A. and Waine, C.V., page 56.
31. Macrae, J.A. and Waine, C.V., page 57.

collier was well developed, and opportunities for new entries to the collier trade were limited. Indeed by the first decade of the twentieth century, all the owners of screw collier fleets were well established, and the only later arrivals were the gas companies who began entering the business from 1902 and the electricity companies in the 1930s.[33]

Conclusions on finance

Ownership on the basis of 64th shares sold through private networks provided an adequate means of financing screw colliers and steam bulk carriers in the decades to the 1870s. Owners raised capital from family and business associates, a method which helped retain control of their ships. Forming a limited liability company was resorted to only when additional capital was needed, and carried the risk that the promoters might lose control, as indeed happened during several general meetings of the General Iron Screw Collier Co. Ltd.[34] and in the case of managing owners Hume, Smith and Co.[35] The limited liability companies formed to operate east coast screw colliers were singularly unsuccessful, and only after 1880 - and then predominantly on the west coast - was this method of finance widely adopted and successful. Thus, the availability of finance through floating limited liability companies, which

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32. Boyce, G., page 186.
33. The first London gas company to build its own screw colliers was the Commercial Gas Company, which needed a specialised vessel to serve its works on the River Lea. Other gas companies followed suit. Chesterton, D.R. and Fenton R.S., *Gas and Electricity Colliers* (Kendal, 1984), page 12.
34. There were several cases of shareholder disaffection. A general meeting in 1859, dissatisfied shareholders resolved that the company should be wound up, although no buyers could be found. *Mitchell's Steam-Shipping Journal* 19th August 1859, page 4 and 10th August 1860, page 506.
35. These Liverpool-based managing owners built up a fleet of steam bulk carriers from 1881, but shareholders in the single-ship, limited liability companies terminated Hume, Smith's management in 1886, probably because of lack of profitability. Fenton, R.S., *Mersey Rovers*, page 124.

grew easier during the 1860s, had little impact on the growth of bulk carrier fleets.

In the 1880s, by when advances in technology had vastly improved the economics of steam bulk carriers (see Chapter Nine), west coast shipowners did see the opportunity to build substantial fleets, and a number took advantage of the single-ship, limited company to finance them. Lack of profitable trading opportunity, therefore, rather than lack of means of raising capital or entrepreneurial spirit, held back the spread of steam bulk carriers to the west coast.

Day-to-day management

With significantly greater costs than the sailing ship, it would be expected that the steamship needed more intensive management to be run profitably.

Sources and methods

Drawing on the limited literature, this section considers the duties and skills required by manager of a bulk-carrying steamship in the latter half of the nineteenth century, and asks whether they were significantly different from those required to manage sailing vessels.

Academic writing on the day-to-day management of shipping is sparse. Business historians have tended to concentrate on the financial aspects of the shipping business, where information in the form of accounts and submissions to the Registrar of Joint Stock Companies and ship registration papers is readily available. For instance, Green produced a very lucid review of the literature on the ownership and financing of British shipping since the beginning of steam for the 1985 Fuji Conference,[36] but other aspects of business have not been well explored.

Parker has given a useful insight into the ownership and management of New England sailing ships trading mainly with coal on the north east coast of the USA.[37] He describes how, in a parallel with UK practice, there were two distinct groups of investors in the New England schooners of the late nineteenth century. One group included those involved in maritime-related services such as ship chandlery or sailmaking, who in return for their investment demanded to have the monopoly of the ship's business in their field, sometimes at inflated rates. The other group were the so-called 'dry' owners with no shipping connections who were interested only in the return on capital, and who - in the case of big investors - were wooed by shipping promoters making the offer of naming the new schooner after themselves or members of their family. Parker also discusses the managing owner or agent who took the initiative in 'getting up a vessel,' in other words signing the building contract and finding investors. He may have been a retired or even an active master, a shipbroker, shipbuilder, chandler or sailmaker, so his occupation either gave him an insight into the problems of running a ship, or a commercial interest, for instance in fixing freights, building, victualling or supplying the ship. Parker is less explicit in discussing the manager's day-to-day activities, mentioning only that he took a

36. Green, E., 'Very private enterprise: ownership and finance in British Shipping 1825-1940' In: *Business History of Shipping - Strategy and Structure*, Tsunehiko, Y and Keiichiro, N, eds., Proceedings of the Fuji International Conference on Business History (Tokio, 1985).

more-or-less active part in the direction of the ship's business, received remittances from the captain and disbursed the dividends, for which he usually received a commission of 2 per cent of earnings, as well as dividends from his personal shareholding.

Ville has described in detail the operation of sailing ship owners in coal and other trades.[38] He identifies the late eighteenth century as the period that shipowning emerged as a distinct occupation previously having been an adjunct to the business of a merchant or other trade. His study ends in 1830 well before the use of steamships in these trades, but nevertheless it is of interest in depicting conditions on board sailing colliers which probably persisted until much later in the century.

Closer to the activities of managing a fleet of steamers are the subjects of papers by Jackson[39] and Palmer,[40] who drew on the detailed minutes of two early British companies operating coastal liner services using steam, respectively the Dundee, Perth and London Shipping Co. Ltd. and the General Steam Navigation Company.

Much of Jackson's discussion concerns matters relevant largely to liner trade operation: provision for passengers, continual adjustment of rates on

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37. Parker, W.J.L., 'Operation and management of the great New England schooners 1870-1900' In: *Problems of Ship Management and Operation 1870-1900.* Papers read at a symposium held at the National Maritime Museum 3rd July 1971.
38. Ville, S.
39. Jackson, G., 'Operational problems of the transfer to steam.' In Smout, T.C. (ed.), *Scotland and the Sea* (Edinburgh, 1992), 154-181.
40. Palmer, S., 'Experience, experiment and economics: factors in the construction of early merchant steamships.' In Matthews, K. and Panting, G. eds. *Ships and Shipbuilding in the North Atlantic Region*. (St. John's, Newfoundland, 1978); Palmer, S. '"The most indefatigable activity": the General

particular classes of goods to limit competition from other operators, and the development of conferences to try to limit competition, optimising sailing schedules to ward off often-suicidal competition, and provision of suitable wharves at Dundee and on the Thames. Once steam is introduced in the 1830s, a prevailing theme is of achieving economies: by working the steamers harder, reducing the size of crews and the wages of crews, saving money on insurance, and reducing wharfage fees.[41]

Jackson points out that effective management was essential for producing the efficiency needed to service the large capital requirements of a line of ships, particularly after the introduction of steam. The company attached considerable importance to its managers, one supervising its office (booking cargoes) the other its quay (loading and unloading) and having responsibility for its accounts. The company was forced by certain shareholders to come to a decision as to whether they would maximise dividends or allow for depreciation and eventual replacement of their ships. Their decision to do the latter was upheld by the courts, a decision which Jackson feels '...established them as a real shipping company.'[42] Introduction of steam in the mid 1830s required reform of financial, managerial and staffing structures, and new operational procedures. The company's directors expended much effort in studying other steam liner operations, but still required to

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Steam Navigation Company, 1824-50' *Journal of Transport History* 3rd series, III, No. 2 (1982), pages 1-22

41. Jackson, G., page 178 for instance.

42. Jackson G., page 158.

consult a steam engine builder, Robert Napier, before coming to their conclusions.

In her consideration of General Steam, Palmer stresses the risks attached to steam shipping, and the severe financial consequences of failure.[43] The very high costs of a steamship compared with sail made steam shipping a much more marginal venture in economic terms than its advantages over sail in speed might suggest: revenue had to be high to compensate for high costs, and intensive working was essential. A quotation from a director of the General Steam Navigation Company in 1839 refers to the energy and skill required to manage ships in the coastal liner trade: 'Steam boats have been found to require in a very great degree the exertion of the most indefatigable activity and rigid economy in every particular of their employment and conduct in order to obtain from them any returns.'

Jackson's and Palmer's analyses of the management problems encountered and solutions adopted have been drawn on for the discussion below. However, consideration of the management of steamers in the bulk trades makes it apparent that the problems faced were different from those experienced in the regular liner trades. No published account of such problems has been found, and indeed source material for such a consideration, in the form of records of early steam bulk carrier owners, does not appear to exist. Perhaps more surprisingly, no account is known of the problems faced by the pioneer operators of deep-sea steam bulk carriers, the ocean-going tramps;

problems which may well have paralleled those of coastal bulk carrier owners. Some enlightenment comes from twentieth century textbooks intended for those in the shipping business.[44]

Day-to-day running of a ship and its business was usually in the hands of managing owners, who raised the capital for the ship and placed the order and who had the necessary skill and experience to run the ship and supervise its employment. They were usually remunerated by a commission on gross freights or net profits, and were practically irremovable from office.[45]

The managing owners' duties are defined as paying attention to the economical working of the vessel, keeping it in good condition and repair, having surveys carried out regularly, insuring hull and machinery, and acquiring tonnage at a suitable time.[46] There is also recruitment of the crew (including specialists such as engineers and firemen) and payment of wages, arranging bunkering and stores; dealing with a broker in fixing a voyage or charter and especially in judging whether the freight or charter rate on offer is the best that can be obtained at the time, preparing instructions to the master, appointing agents at the ports visited, deciding on future fixtures based on his reading of the market for freights, keeping accounts, and making statutory returns (e.g. to Registrar of Companies).

43. Palmer, S., pages 1-22.
44. For instance, MacMurray, C.D. and Cree, M.M., *Shipping and Shipbroking*, 2nd edition (London, 1925).
45. Fayle, C.E., *A Short History of the World's Shipping Industry* (London, 1933), page 267.
46. MacMurray, C.D. and Cree, M.M., *Shipping and Shipbroking*, 2nd edition (London, 1925), page 316.

Management requirements of the bulk-carrying steamship

Consideration of the above and the needs of operating a coastal steam collier or bulk carrier suggests the following need to be addressed by the manager of steam bulk carriers:

Raising the capital

Setting the specification for the steamer and supervising construction

Appointing navigating and engineering officers and crew

Fixing cargoes and/or arranging charters

Expediting loading/unloading with as much despatch as possible

Arranging and supervising repairs and stores for the ship

Administration, including collecting freight money, disbursing dividends, complying with the requirements of the Board of Trade and the registrars of ships and companies, and arranging insurance cover.

To what extent did the skills, time and energy needed to conduct these operations differ from those needed for the operation of a sailing ship in similar trades? Answering this question will shed light on the management resources needed by a steam shipping company in the bulk trades.

Raising the capital

Sources of finance have already been considered, but what of the process of raising the capital? Data collected from Custom registers (presented in the appendix) shows that ownership of the majority of the steam colliers built up to the 1870s was in the hands of a distinct group of men, almost all of the major investors being coal factors, coal owners, coal merchants, with a lesser number of sundry, and invariably small, investors. Given that many of those in the coal trade would know each other, and probably were in day-to-day contact, raising capital through such a network would not be a time-consuming business, certainly no more difficult than for financing a sailing vessel. However, the limited liability companies, especially the General Iron Screw Collier Co. Ltd., were looking for a wider financial base and here much more management and clerical time would be required for circulating prospectuses, registering shareholders and ensuring capital was paid up.[47] The managers would also need to run board meetings and general meetings, the latter often appearing to have been stormy. These operations needed a substantial administrative base, requiring communications, financial, clerical and other skills that would be outside those required for a basic shipping operation.

Specification and supervision of construction

Expertise in the construction of iron steamships in the 1850s was largely with shipbuilders; those on the Thames such as John Scott Russell being particularly skilled.[48] Charles Palmer was an exception; with no shipbuilding background he set up a very successful business which concentrated almost from the outset on building screw cargo ships, and bought in iron shipbuilding skills from Clydeside.[49] These and other established builders mainly on the Tyne, Wear, Thames and Mersey built almost all the early steam colliers. It is most unlikely

47. National Archives, BT31/172/519.
48. Emmerson, G.T., *John Scott Russell: a Great Victorian Engineer and Naval Architect.* (London, 1977). Scott Russell was probably the pre-eminent naval architect of his day, and one of the few shipbuilders who could undertake the construction of the Great Eastern in the mid-1850s.

that the shipowners, drawn largely from those in the coal trade, could appreciate, let alone add to, the technical skills and experience of the shipbuilders and engine manufacturers. The owners' contribution would largely be in setting (or agreeing) some parameters, including length, capacity, speed, coal consumption and cost, and leaving the detailed design to the builders and engineers who were rapidly gaining expertise in the new technologies of constructing both iron hulls and steam engines driving screws.[50] In addition, surveyors from Lloyd's Register or another classification society would be on hand to ensure the yard built to an acceptable standard. The shipowner would therefore need to devote little management time or effort to specifying and supervising the construction of a steamer.

Appointing officers and crew

The steamship owner or manager had to find engineers and firemen. The former were probably recruited from marine engine builders; the latter were probably trained on the job. Crew agreements were typically for a six-month period in the coastal trade.[51] The impression from these is that turnover of crew was relatively low, probably because the steamer offered more attractive

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49. Charles Palmer's Letter Book, Tyne and Wear Archives 1357/7. Palmer appointed John MacIntyre, a Glasgow shipbuilder, as his yard manager shortly before his second hull, the screw collier *John Bowes*, was launched, MacIntyre offering to bring with him men from Clydeside.
50. Owners of ocean-going tramps continued for many years to set a very general specification for their ships, approached several builders, and accepted the lowest tender price with the best delivery date. Quite probably, the owner or his representatives saw the hull for the first time when they came to attend the launch. In contrast, owners of cargo and passenger liner tonnage, which was more likely to be specially designed for the requirements of the owner's trade, came to set much more tighter specifications, with the owners representatives being in the shipyard from comparatively early in the construction process.
51. Crew agreements for the 1850s and early 1860s are available in the National Archives and the National Maritime Museum, and were extensively consulted to determine trading patters, as discussed in Chapter 2.

employment opportunities with shorter and more predictable voyages than a contemporary sailing vessel.[52] It seems unlikely that, once a supply of steam engineers and firemen had been established, the owner or manager of a steamer would need to devote much more time and effort than his sailing ship contemporary to appointing crew, and much of the work may have been delegated to the master or chief engineer.[53]

Fixing and chartering

Crew agreements indicate that many steam colliers running in the coastal trade had more-or-less regular routes. In 1859 and 1860, for example the *Countess of Durham* made 34 and 40 voyages, respectively, every one between Sunderland and the Thames.[54] This suggests that it was on fixed, long-term contracts, either with coal owners, coal merchants or gas companies. Indeed, many of the screw colliers were owned by those in the coal trade, and this would help assure them of regular employment. Apart from initially arranging the contract, and any periodic renegotiations, management involvement would be small.

This contrasts with the situation where a coastal steamer would be tramping, and hence looking for a new cargo after each short voyage. Then, management would need to be considerably more energetic, with the need to liaise with those having cargoes available to ensure the steamship was working

52. Nevertheless, the crew of a screw collier could be overworked. Macdonald, a Thames pilot called to give evidence for the Thames Conservancy Bill in 1863, notes that a screw collier would enter Victoria Dock where there were hydraulic cranes to unload it, and discharge and sail in as little as 12 hours, giving the crew very little time to rest. Parliamentary Papers, Select Committee on the Conservancy of the Thames; 1863, XII, 1.
53. In the earlier part of the nineteenth century, the master was largely responsible for appointing the crew. Ville, S., page 68.
54. National Archives, BT98/5679 and BT98/6365.

as intensively as possible to meet its higher capital and running costs. The time of the earliest steam colliers, the 1850s and 1860s, coincided with the development of better communications, particularly the telegraph, which enabled the shore-based ship managers to keep in touch with the network of agents and brokers who would have cargoes on offer.[55] As demonstrated in chapter 4, the steam bulk carrier on the west coast could not rely on such large and steady flows of cargo as were available between the Tyne and Wear and the Thames. They needed to be more flexible in their routings to find sufficient cargoes, and hence they needed more shore-based management effort. This factor may have put west coast owners of bulk carriers at a small disadvantage compared to their east coast contemporaries.

Expediting loading/unloading

Referring to liner services, Palmer points out that, because of the high fixed costs of steamers, their success depended on making regular and frequent voyages with little spare capacity.[56] Frequent voyages were, if anything, more important to the steam bulk carrier, whose cargoes were not of high value. It was vital to their economics that loading and unloading were carried out as promptly as possible to ensure the vessel was idle, and hence not earning, for as short a period as possible. Minutes of the gas companies, particularly of the Gas, Light and Coke Company, indicate that owners offering them steam colliers on charter in the 1850s insisted on clauses limiting the period when the

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55. Armstrong, J., 'Management response in British coastal shipping companies to railway competition.' *The Northern Mariner* VII (1997), page 26; Fayle, C.E., *A Short History of the World's Shipping Industry* (London, 1933), page 263. Ocean telegraphs date from 1850s and 1860s.

colliers were waiting to load or unload, beyond which demurrage payments were made over and above the charter rates.[57] These minutes also reveal that responsibility for loading and unloading was taken by the agents of the gas company so, other than monitoring the time spent awaiting to load or unload (and this was undoubtedly done by the master of the individual vessel) and making any necessary claims for demurrage, the owner had little to do in this respect.

The same situation probably held for vessels not on charter to gas companies. Reminiscences of those who sailed in or owned steam bulk carriers in the twentieth century suggest that it was regarded as the master's responsibility to do all he could to expedite loading and discharge, and retention of his job may well have depended on his success.[58] Therefore involvement of management, who were usually remote from the scene of loading or discharge, was negligible.

Arranging and supervising repairs

The frequent reports of damage in the daily casualty columns of *Lloyd's Lists* indicate that ships in the coastal trade were particularly prone to minor accidents. They navigated in confined waters and frequently entered and left docks and locks where they came into violent contact with fixed structures and

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56. Palmer, S., page 8.
57. Minutes of the Court of the Gas Light and Coke Company, in the London Metropolitan Archives. Minute books B/GLCC/23/1 to B/GLCC/26/1 cover the 1850s.
58. See for instance Spargo, O.G. and Thomason, T.H., *Old Time Steam Coasting* (Albrighton, 1982) and Coppack, T., *A Lifetime with Ships* (Prescot, 1973). Owen Spargo was mate and later master on many west coast steam bulk carriers whilst Tom Coppack was a member of a family in Connah's Quay, North Wales who owned a small fleet of sailing vessels and steamers involved in coastal tramping round the Irish sea.

other vessels. They habitually took the ground in some harbours, so their bottoms were vulnerable to damage from uneven berths or obstructions. Accidental groundings in tidal rivers were also a part of life, as masters under pressure to get into and out of ports as soon as there is sufficient depth of water misjudged the state of the tide. Loading and unloading bulk cargoes was usually done as quickly as possible without much care, so coal was teemed into the hold from a considerable height, whilst mechanical unloading (introduced as early as 1855 for steam colliers serving the Thames) could result in grab damage to the hold. Early steam machinery was untried and prone to breakdown. Boilers required replacing frequently, perhaps every three to five years. Surveys required by the Board of Trade or classification societies such as Lloyd's Register would necessitate dry docking and surveyor's fees.

Thus, coastal vessels continually required repairs and attention to hull and machinery. The expenses of repairing the steamers of an early steam liner company, the Dundee Perth and London, were so great and frequent that the company considered making the senior officers contribute to the costs of collisions, but eventually decided on the more equitable process of awarding bonuses in collision-free years.[59] The General Steam Navigation Company's report in 1839 had lamented that:

'The expenses required to maintain steam ships in a proper state of efficiency and repair have been found to reach so large an annual amount that,

59. Jackson, G., page 165.

of the numerous steam companies which have been formed, scarcely one has been found…able to maintain...a dividend of five per cent…'[60]

The author has examined the records of a company operating a relatively new coastal steamer in the early twentieth century, the *Grosvenor* of the Aberystwyth and Aberdovey Steam Packet Co. Ltd. Although only four years old in 1912, the *Grosvenor's* repair bill was over £1,000, a sum almost equivalent to the costs of crew and coal, in a year in which earnings from freights were £6,500.[61] Repairs to *Grosvenor* were thus a significant part of her total costs. The year 1912 was not exceptional in terms of repairs needed.

Arranging for repairs would almost certainly devolve on the owner or manager, as they would be anxious to get the work done as economically as possible and with the least delay. They would also be better placed than the master, who was at sea, to arrange for repairing and surveying to be carried out. Some work on the machinery and boilers was done by the engineers during periods in port when steam was not required, but the more major repairs and renewals needed shore-based expertise, equipment and workshop facilities. Likewise, repairs to hull fabric needed shoreside equipment (and often a dry dock) and is not something the crew would be able to tackle, their maintenance role being confined to cargo gear, rigging and painting.

Wooden sailing vessels required a similar, and perhaps even greater, amount of repair work and, although no engineering work on engines and boiler

60. Quoted in: Palmer, S., page 7.

was needed, rigging and sails were in constant need of repair and renewal, this being done where possible by the crew. In the case of a steamer, repair and remedial work needed to be done more expeditiously to avoid keeping it out of revenue-earning service. Therefore the move from sailing ship to steam ships in the coastal trade probably necessitated more management time and involvement in organising repair work.

Administration

Administrative duties of a ship's manager included collecting money earned from freights, disbursing dividends to shareholders, complying with official requirements of the Board of Trade and with Customs officials acting as Registrars, and the Registrar of limited companies, arranging insurance cover, and paying crew's wages. Some of this activity was devolved to the agent in a distant port or to the master. There seems no reason why these duties should be any more onerous than those involved in running a sailing ship, although more voyages would mean more freights to be collected.

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61. Minute books of the Aberystwyth and Aberdovey Steam Packet Co. Ltd. in Gwynedd Record Office, Caernarfon. The figures are quoted in Fenton, R.S., *Cambrian Coasters* (Kendal, 1989), page 43.

The rise of the ship manager

The rise of the ship manager or management company coincided with the development of the bulk carrying steamer.[62] The ship manager developed from the managing owner or ship's husband, whose appointment was required by the 1854 Merchant Navy Act, and who was an individual nominated by the owners to take responsibility for the vessel. Essentially, Parliament was asking for the name of someone who could be held to blame if the ship defaulted in any way.

Several factors assisted the rise of the ship manager. The increasing ease of financing a ship through a limited liability company, and the concept of the single-ship company, encouraged the more entrepreneurial individuals in the shipping industry to promote their own companies, especially in the tramp trades, during the latter part of the nineteenth century. The successful managers floated further companies, and the number of ships under their operational control grew until they comprised considerable fleets which needed a shore-based administrative and management operation. Factors driving the change were the growth of the steamship with its ability to earn more than a sailing ship if worked intensively, and the improvement in international communications (for instance, the telegraph) which gave a manager based in Cardiff or Newcastle up-to-date information on the state of markets for shipping in distant continents and - a necessary accompanying condition - the

62. The best discussion is probably in a chapter entitled 'Commercial organisation and the freight market' of Craig, R., *The Ship: Steam Tramps and Cargo Liners 1850-1950* (London 1980), pages 39 to 44, which is the basis of the first two paragraphs of this section.

ability to direct a ship to the most appropriate port to take advantage of the best market.

The phenomena of ship manager was not limited to the steamship, however. The fleets of large ocean-going sailing ships which grew in the latter part of the nineteenth century were managed in exactly the same way as fleets of ocean-going tramp steamers.[63]

The rise of the ship manager was more a consequence of the development of the steamship, the more liberal financial climate, and better communications than a major factor driving the rise of the bulk carrying steamer. The more intensive management regime it engendered could benefit both the steam and sailing ship owner equally, although it undoubtedly gave an edge to the steamer, with its need for more intensive employment to achieve profitability.

Conclusions on management

Did management need to change with the transition from sail to steam in coastal bulk trades? Detailed examination of the responsibilities and duties of the owner or manager of steam bulk carriers suggests that the answer is yes: this individual would have more to do and less time to do it in than his equivalent in sailing ship ownership or management. However, the burden on the manager would only be significantly larger if limited liability status was adopted, requiring administrative and management time to be devoted to

63. See, for instance, Eames, A. *Ventures in Sail.* (Caernarfon, 1987) which discusses the deep-sea ship managers of North Wales. There were similar managers in Liverpool and Glasgow.

registering shareholdings and other statutory requirements. As was shown earlier in this chapter, only a minority of the steam colliers and steam bulk carriers built up to 1870 were financed in this way. It is concluded that the total management effort and expense required for the average steamship would be greater but not significantly so than for a sailing vessel in similar trades.

A second question is whether the east coast owner was at an advantage over the west coast owner when it came to steamship management. The east coast owner of steam colliers was often a coal merchant, coal factor or colliery owner. Shipowners such as Charles R. Fenwick and John Fenwick senior and junior, William Stobart, Frederick Harris, James Dixon, James Joicey, Frederick D. Lambert, the Lambtons, Lord Londonderry, and William Cory and Sons were already established and would have shore-based administrative staffs. They had excellent connections both with collieries and consumers of coal, such as the gas companies. For instance, Harris and Dixon were acting as middle men in supplying at least 20,000 tons of coal annually to the Gas, Light and Coke Company in the early 1850s.[64] Given their office facilities, and their commercial connections, bolting on the functions of steamship management would not be difficult for these commercial organisations. Indeed, John Fenwick moved so far away from his original business as a coal fitter that by the 1863 he no longer described himself as a coal factor but as a shipowner, although he still gave his address as the London Coal Exchange.[65]

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64. Minutes of the Chartered Gas, Light and Coke Company; London Metropolitan Archives B/GLCC 23/1, 24/1 and 25/1, covering March 1852 to July 1858.
65. For instance in the registration documents of the *Ellen Sinclair*, National Archives, CUST 130/56.

On the west coast there was not the same well-established commercial network, and in the 1850s, 1860s and 1870s it was mainly colliery and possibly quarry owners who had the office-based administrations that could develop into steamship management companies. When companies managing bulk carrying steamships did arise on the west coast in the 1880s, several came from shore-based organisations: from shipbroking in the case of Richard Hughes of Liverpool,[66] and from a coal merchant business in the case of the biggest of them all, William Robertson of Glasgow.[67] There were casualties, however, such as the little known enterprise of Hume and Smith which built seven steamers in two years for single-ship companies but then had their management abruptly terminated by the shareholders in these companies.[68]

The coal-shipping business interests on the east coast therefore had an initial advantage in having existing administrative organisations to which steamship managing activities could readily be developed or added. The importance of this, however, should not be exaggerated: west coast owners such as Richard Hughes, William Robertson, the Hay and Mack families could and did develop their own successful management expertise in the 1880s.

Conclusions

In the latter half of the nineteenth century financial liberalisation, and especially the increasing ease of floating limited liability companies, did little to facilitate the spread of the bulk-carrying steam ship with its greater demands for capital

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66. Fenton, R.S., page 84.
67. Waine, C.V. and Fenton, R.S., *Steam Coasters and Short Sea Traders* (3rd ed. Albrighton, 1994), pages 160-161.

than the sailing ship. Most steam ships were financed, as were their sailing ship predecessors, on the time-honoured 64th share basis through networks involving those with family or business ties.

The duties of and skills required by a steamship manager were not substantially different in kind from those of his sailing ship contemporary, although the steamship man had more to do, and less time to do it in. Indeed, managers of sailing ships also had to adopt more intensive practices if they were to continue to compete with the steamer.

Therefore it is concluded that neither changes in finance nor management practice made a significant contribution to the rise of the steam bulk carrier in the late nineteenth century.

There is little evidence that such changes as there were favoured east coast over west coast owners. Only a small number of owners on each coast adopted limited liability status in the 1850s and 1860s, and these were singularly unsuccessful. From the 1870 onwards, the west coast owners were, if anything, more willing to float single-ship, limited liability companies. The need to manage steamers more intensively may have given a small initial advantage to the east coast owners, with their pre-existing offices, but west coast owners quickly caught up. Differences in financial and managerial practices cannot account for the difference in uptake of steam bulk carriers between the coasts.

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68. Fenton, R.S., page 124.

CHAPTER NINE: EAST AND WEST COAST STEAM BULK CARRIERS COMPARED

This chapter looks at the suggestion made in chapters 4 and 5 that the screw collier developed for the east coast trade was a distinctly different species of ship from the steam bulk carrier which eventually became widely established in coastal trades, particularly those on the west coast of the UK. If a distinct type of steamer needed to be developed for the west coast, it may help explain some of the delay in steam penetrating west coast trades. Factors considered are where the ships were built, the characteristics of the ship types and how they evolved.

Sources and methods

The major source comprises registers, including *Lloyd's Register*, the *Liverpool Underwriters Register*, the *Mercantile Navy List* and registration documents held in the National Archives, which give dimensions and, from the 1880s, details of ballast capacities. Some plans of colliers and coasters have been published, mainly by Waine. Methodology is discussed in the relevant sections.

Builders of coastal bulk carriers

In the major published history of the steam coaster, Waine infers that these vessels evolved from early screw colliers[1] such as the *Bedlington* of 1845, the *Collier* of 1849, and particularly the *John Bowes* of 1852. If this is correct, it would be expected that the yards which built the screw colliers in some

1. Waine, C.V. and Fenton, R.S., *Steam Coasters and Short Sea Traders* (3rd ed. Albrighton, 1994), chapter 4.

numbers from 1852 onwards would have taken advantage of their experience and built bulk carriers for the slowly-developing west coast trades. Craig implies that the market for bulk carriers was satisfied by east coast builders '...West Coast of England shipbuilders were less active in the construction of bulk carrying steamers in the 1840s and 1850s than their East Coast contemporaries...'[2]

To discover whether screw collier builders on the east coast made the transition to building vessels for the west coast, all known iron coastal bulk carriers built up to 1870 have been listed by builder (table 9.1). The details of builders are taken largely from registration documents, but not all of these recorded the name of the hull builder.[3] As some early, experimental and short-lived vessels are included in these figures the totals do not tally exactly with those in chapter 4, which includes only known bulk carriers active between 1850 and 1870.

Table 9.1 shows that the above expectations about east and west coast builders are completely reversed. Despite their enormous expertise in building screw colliers, east coast yards won very few of the (admittedly sparse) orders for bulk carriers for the west coast, building only seven out of the known 31 vessels which traded on the west coast to 1870. Palmers are the most spectacular example: they built 55 east coast colliers (three out of every ten built in this period) but only one west coast steamer, the *Morfa*, despite their founder's aggressive marketing. The next most prolific collier builder, James

2. Craig, R., 'Aspects of tramp shipping and ownership' in Matthews K. and Panting G. (eds.), *Ships and Shipbuilding in the North Atlantic Region* (St. John's, Newfoundland, 1978), page 215.
3. Classes BT 108, BT 109 and BT 110, and CUST 130 in the National Archives.

Laing of Sunderland, built none for the west coast. Both Palmers and Laings went on to have very successful careers building much larger vessels. The only east coast yard found to have built more than a single west coast steamer was Richardson, Duck and Co. on the Tees, but their products - the specialist, shallow-draft china clay carrier *Cuirassier* of 1860 and the collier *Lady Alice Hill* of 1866 - suggest no continuity in design.

West coast builders contributed more ships (a total of 14) for east coast trades than east coast builders did for west coast trades. Thomas Vernon at Liverpool, for instance, built four colliers between 1852 and 1854, the *Haggerston* being completed only a month after the pioneer *John Bowes*, and employed novel double-bottom tanks. However, despite this lead, Vernons did not go on to become major suppliers of small steam bulk carriers to local owners, building only one, the *Annie Vernon* of 1856. Many of the bulk carriers built for west coast owners up to 1870 were one-offs, their builders not being known to have constructed others. The two exceptions are Harveys of Hayle, who built three for their own account, and Bowdler, Chaffer of Seacombe on Merseyside who built four between 1865 and 1867. However, neither of these yards went on to become significant suppliers of coastal bulk carriers.

Waine has assigned the steam coasters existing in 1927 to builders, producing a chart which shows the percentages of the total built by the more important builders, others being assigned to builders in broad geographical areas.[4] Although 13 years beyond the period of this study, this is a useful comparison as many vessels would have been built before 1914, and in any case most major builders of steamers were well established before the First World War.[5] Waine's work shows that only one of the builders in table 9.1 continues as a significant coaster builder, Smith's Dock of Middlesbrough, successors of T. and W. Smith of North Shields. Builders of steam coasters are based equally on the Clyde and on the east coast of England (the Tyne, Wear, Tees and Humber) - yards in these two geographical areas accounting for about 80 per cent of the 1927 fleet. As Waine is almost certainly counting steam colliers built for east coast routes in these figures (other chapters in his book give these equal prominence with the west coast-based vessels), and these colliers continued to be built in large numbers on the Tyne and Wear, it is apparent that the Clyde builders (who hardly appear in table 9.1) are largely responsible for building, and presumably developing, the smaller west coast bulk carrier. Design features such as water ballast tanks and double bottoms were adopted as a result of pioneering work done in east coast yards, but the smaller, predominantly west coast-based bulk carrier did not grow out of the east coast collier and its development was largely in the hands of yards listed by Waine such as Fullertons of Paisley, Ailsa of Ayr and Troon, Scott of

4. Waine, C.V. and Fenton, R.S., page 11.
5. Several yards were either newly set up to build coasters after the war, or turned from building fishing vessels or purely ship repair work to coaster construction. In the very unfavourable economic circumstances which set in for shipbuilding early in the 1920s, their output was relatively small and they quickly went bankrupt or returned to repair work. See, for instance, Fenton, R.S. and Guegan, M., 'Hansen Shipbuilding, Bideford' *Ships in Focus Record* No. 14, 2000, pages 75-81 and 15, 2001, pages 158-163.

Bowling, the Ardrossan Dockyard, and Williamson of Whitehaven. These were yards which did not participate in the building of colliers.

Table 9.1. Builders of bulk carrying steamers up to 1870

Data extracted from ships' histories in Appendix 2. West coast vessels are shown in italics.

Where known, the yard number appears after the name.

Bainbridge, Willington Quay-on-Tyne
1865 SOUTHAMPTON
1865 BASINGSTOKE

Barclay, Curle & Co., Glasgow
JESSIE BROWN

Bowdler, Chaffer and Co., Seacombe
1865 KIRKLESS
1865 AGNES JACK
1865 JANE BACON
1867 LANCASTER

Candlish, Middlesbrough
1866 SUNDERLAND

J. Clayton, Liverpool
1855 CARBON

J. Couttts, Walker-on-Tyne
1844 Q.E.D.

George Cramm, Dee River Yard, Roodee, Chester
1854 CHESTER
1855 DERWENT

Denny, Dumbarton
1847 DUMBARTON YOUTH

Alexander Denny, Dumbarton
1853 CHANTICLEER 29

Gill, Sunderland
1868 OTTERCAPS

Harvey & Co., Hayle
1864 BRIDE
1865 BESSIE
1867 HAYLE

Haswell, Sunderland
1865 NATALIAN

Henderson, Renfrew
1866 DORSET

I.M. Hoby and Co., Renfrew
1854 IRON AGE
1856 WILLIAM FRANCE

Robert Irvine & Co., West Hartlepool
1866 OGMORE

James Laing, Deptford, Sunderland
1854 GREAT NORTHERN
1855 VULTURE
1855 WEARMOUTH
1855 VEDRA 217
1860 SAMSON
1860 DEPTFORD
1861 EARL OF ELGIN
1861 GENERAL HAVELOCK
1861 HASWELL
1861 LADY HAVELOCK
1861 NEWBURN
1862 MEDUSA
1863 GEORGE ELLIOT
1863 LADY BEATRIX
1864 BIDDICK 271
1865 BELMONT
1865 CAMBRIDGESHIRE
1865 HARTLEPOOL
1865 LUMLEY
1866 KELLOE
1865 PRIMUS
1866 SHERBURN
1867 HARRATON
1867 WEARDALE
1868 LANGLEY
1868 TYNEDALE
1868 GENERAL CODRINGTON (2)
1869 RYHOPE 234
1869 FINCHALE
1869 FRANKLAND
1869 RESOLUTE

London and Glasgow Engineeering and Iron Shipbuilding Co. Ltd., Govan
1865 CROMWELL
1865 FAIRFAX

Charles Lungley, Deptford Green/Rotherhithe, London
1854 UNION
1854 NORMAN
1855 DANE
1863 BLONDE
1864 MAY QUEEN

McNab, Greenock
1866 WILLIAM COULMAN

C.J. Mare and Co., Blackwall, London (1857 became Thames Ironworks & SB Co. Ltd)
1853 RAJAH

Thomas D. Marshall, South Shields
1841 BEDLINGTON
1847 CONSIDE
1853 LADY ALICE LAMBTON
1862 VOLUNTEER
1866 DERWENT (2)

Maudslay, Sons & Field, East Greenwich, London
1865 LADY DERBY

Millwall Iron Works
1864 NEWTON COLVILLE

C. Mitchell and Co., Low Walker, Newcastle-upon-Tyne

1854 EARL OF DURHAM
1854 HETTON
1855 KILLINGWORTH
1856 EUPATORIA (?)
1857 WILLIAM CORY 28
1857 LYON 29
1857 LAMBTON 33
1863 JOHN LIDDELL
1870 JOHN JOHNASSON

T.R. Oswald and Co., Pallion, Sunderland

1861 EDITH
1865 FATFIELD
1865 WEAR
1866 HAMPSHIRE (1)
1866 HOUGHTON

Palmer Brothers and Co., Newcastle-upon-Tyne (Jarrow, Willington and Hebburn)

1852 JOHN BOWES 2
1852 WILLIAM HUTT 3
1853 COUNTESS OF STRATHMORE 4
1853 NORTHUMBERLAND 5
1853 SIR JOHN EASTHOPE 6
1853 DURHAM 7
1853 JARROW 8
1853 MARLEY HILL 10
1854 ROSS D. MANGLES 12
1854 NICHOLAS WOOD 13
1854 COCHRANE 19
1854 SAMUEL LAING 21
1854 BLACK BOY 23
1854 WHITLEY PARK 26
1854 BLACK SEA 27
1855 NORMANBY 28
1855 SARDINIAN 29
1855 GEORGE HAWKINS 32
1855 GENERAL CODRINGTON ?
1855 HUTTON CHAYTOR 34
1855 EARSDON 38
1855 SARDINIAN 39
1856 MARMORA 43
1857 SEATON 56
1857 ROUEN 64
1859 JAMES DIXON 88
1866 BOSTON 196
1860 SENTINEL 93
1860 HENRY MORTON 95
1861 SIR JAMES DUKE 103
1861 HAWTHORNS 104
1861 JOHN FENWICK 105
1861 BRUNETTE 107
1862 MORFA 114
1863 JOHN MCINTYRE 127
1863 JAMES JOICEY 128
1863 FANNY LAMBERT 135
1864 DESPATCH 145
1864 JOHN R. HINDE 152
1864 ORWELL 156
1864 TANFIELD 166
1864 THOMAS LEA 146
1865 CONSERVATOR 169
1865 MARY NIXON 175
1865 NEW PELTON 181
1865 BERRINGTON 185
1865 JM STRACHAN 186
1865 ME CLARKE 187
1865 NEW PELTON
1865 CS BUTLER 188
1865 MARGAM ABBEY 195
1866 MERTHYR
1866 TREVETHICK 203
1867 JE McCONNELL 214
1869 BECKTON 244
1869 NORTHUMBRIA 245

Ebenezer Pike, Cork

1860 IBIS

John Pile/Pile, Spence, West Hartlepool

1857 LONDONDERRY 8
1865 WISBEACH

J.T. Price, Neath Abbey

1849 JOHN

J. Ray, Sunderland

1845 EXPERIMENT

John Reid and Co., Greenock
1849 COLLIER

Richardson Brothers, Hartlepool
1856 FLORENCE NIGHTINGALE 10

Richardson, Low Walker
1864 BEBSIDE

Richardson, Duck and Co., South Stockton
1855 COUNTESS OF DURHAM
1860 *CUIRASSIER*
1866 LADY ALICE HILL 6

Samuda Brothers, Poplar, London
1854 SAXON
1854: BRITON
1857 WINDERMERE
1869 DROMEDARY

M. Samuelson and Co., Hull
1857 VELOCITY
1861 FALCON

Schlesinger, Davies and Co., Wallsend, Newcastle-upon-Tyne
1867 ASTON 10

J. Scott Russell and Co., Millwall, London
1852 LADY BERRIEDALE
1853 CAROLINE
1853 FALCON
1853 EAGLE
1854 IMPERIAL
1854 HAWK
1855 NEW PELTON (1)

J.E. Scott, Cartsdyke, Greenock
1855 BERWICK

T.B. Seath, Rutherglen
1864 VANDERBYL

Simons, Renfrew
1857 CONTEST

T. and W. Smith, North Shields
1861 TOM JOHN TAYLOR
1863 BLACK DUCK
1864 BLACK SWAN 22
1865 HASTINGS 24
1865 DUDLEY 29
1865 JAMES SOUTHERN
1865 WENTWORTH
1867 BRADLEY
1869 BLUE CROSS

J.K. Stothert and Co., Bristol
1856 THOMAS POWELL

Sturge, Swansea
1849 AUGUSTA

Swan Brothers, Dumbarton
1867 LADY ALICE KENLIS

Union Shipbuilding Co., Kelvinhaugh
1864 NORSEMAN

T. Vernon and Son, Liverpool
1852 HUNWICK
1852 HAGGERSTON
1854 BLACK PRINCE
1854 FIREFLY
1856 ANNIE VERNON

Walpole, Webb and Co., Dublin
1866 DUBLIN

Wingate, Glasgow
1866 LUDWORTH
1866 THORNLEY

Unknown, Danzig
1863 MARIE

Unknown, Hartlepool
1855 RECHID
1857 ANN

Unknown, Liverpool
1857 JAMES KENNEDY

Unknown, Lancaster
1867 LLYSFAEN

Unknown, Millwall, London
1866 SALISBURY

Unknown, North Shields
1853 PRESTON

Unknown
1854 JULIA
1854 WILLIAM ALDAM
1854 WILLIAM BECKETT
1855 UNANIMITY
1856 ST. GEORGE
1862 MIRIAM
1862 SARAH
1865 PRESTON BELLE
1865 WILLIAM HUNTER

The Clyde puffer and the coaster

At least one yard which built coasters in the 1870s - Swan Brothers of Maryhill - had built small screw steamers known as Clyde 'puffers'. Initially developed for use on the Firth of Clyde and its connecting canal system, puffers frequently made coastal and short sea passages despite their modest size.[6] Waine estimates that around 400 puffers were built, making them a very important group of small steamers.

Did these small but effective steamers contribute to the development of the larger steam bulk carrier? Puffers were strictly limited in length by dimensions of locks on the canals they used (to 88 feet in the case of the Crinan Canal, and just 66 feet for those using the Forth and Clyde Canal), and the experience of their designers in installing an efficient steam plant in a small hull would have been valuable in designing sea-going bulk carriers. This view was expressed during discussion of a paper presented to the Institution of Engineers in December 1953 by a descendant of William Robertson, one of the pioneer owners of coastal bulk carriers.[7] Pointing out that Robertson's first vessels were puffers, and claiming that the puffer was the first steam coastal tramp, a speaker from the floor went on to argue that yards at Maryhill (Swan) and Kirkintilloch (Hay, and McGregor) constructed 'extra long puffers', which

6. There have been several books about Clyde puffers, but they tend to be anecdotal, and at times romantic, rather than analytical. McDonald, D., *The Clyde Puffer* (Newton Abbott, 1977) is well illustrated but short on text. Paterson, L., *The Light in the Glens: the Rise and Fall of the Puffer Trade* (Colonsay, 1996) scampers through the puffer's history to dwell at length on the post-Second World War fortunes and misfortunes of the last surviving puffer owner, Glenlight Shipping. Chapter 5 of Waine, C.V. and Fenton, R.S. is devoted to puffers, but is concerned mainly with constructional details of specimen craft. Burrows, G.W., *Puffer Ahoy!* (Glasgow, 1981) is anecdotal, rambling and disorganised. The author of this thesis has contributed Fenton, R.S., 'The Clyde Puffer' *Archive*, 2001; 30: 49-64. The early history of this type of craft deserves further study.
7. Robertson, J.C. and Hagan, H.H., 'A century of coaster design and operation'. *Transactions of the Institution of Engineers* 1954; XCVII: 204-256.

were built in two parts and towed to Bowling to be put together. He felt that each half of the coaster was like a puffer, being very bluff and not at all like the schooners they superseded. In their reply, Robertson and Hagan doubted whether this was strictly accurate, and pointed out that the coastal tramp has proportions and hull form entirely different from the puffer. 'The mere elongation of the original puffer form would not produce the desired sea-keeping qualities which were clearly apparent in the six coasting tamps constructed for the fleet analysed in the years 1877-1880, and immediately following on the puffers mentioned.'

There is much in the history of the puffer that supports Robertson and Hagan's separation of the puffer and the coastal bulk carrier. Throughout their long constructional life (they were built in very considerable numbers for use by the Admiralty during the Second World War) puffers remained a very distinct class of steamer, retaining much of their simplicity including a lack of any double bottom or facility to carry water ballast. Their trade was limited by their modest size, which was determined absolutely by the locks on the canals they habitually used. This led to the operation of puffers remaining distinct from that of larger coasters. Of the two major operators, Ross and Marshall of Greenock had only one or two coasters in their fleet, but had many puffers.[8] The Hays of Kirkintilloch kept their puffer and coaster operations entirely

8. Paterson, L., pages 48-57.

separate, one side of the family being involved in running, building and repairing coasters, and the other in larger coasters.[9]

Although the success of the puffer, the first of which is dated to a conversion of a lighter to steam propulsion in 1857, may have encouraged builders and owners to exploit the potential of steam in the coastal bulk trades, we must look elsewhere for the origin of the west coast bulk carrier.

Development of the coaster

Table 9.2 lists known steam bulk carriers likely to be operating on the west coast between 1849 and 1869. As already discussed, the number is relatively small compared with those on the east coast. A variety of builders were involved, none contributing more than four ships, and many only one. There is also enormous disparity in terms of size, which ranges from 74 feet to 211. This reflects the different trades for which the ships were destined; for instance, the harbours of the Bristol Channel would require much smaller vessels than the coal trade from Cardiff or the Mersey to Dublin or Belfast. This variety of trades is, as already discussed, a distinguishing feature between east and west coast environments.

The overall impression is of vessels being built piecemeal to various sizes to suit a variety of trades, probably with individual builders developing their own ideas, and there being too few repeat orders to allow a builder to develop a design. There was thus unlikely to be the opportunity for the type of evolution that saw the screw collier develop in a very short

9. Bowman, A.J., *Kirkintilloch Shipbuilding* (Kirkintilloch, 1983) is devoted largely to a history of the Hay family's shipbuilding and shipowning activities.

time on the east coast, with its common requirement for an efficient, durable system of carrying water ballast.

Table 9.2: West coast bulk carrying steamers 1849-1869

Derived from a survey of Lloyd's Register, Parliamentary Returns, Customs Registers and other sources (see appendix 2 for further details).

Name	**Date**	**Length**	**Built**	**Likely trade**
Dumbarton Youth	1847	117 feet	Denny, Dumbarton	Iron ore
Express	1847	147 feet	Harvey, Hayle	Bristol Channel
Augusta	1849	140 feet	Sturge, Swansea	Iron ore
John	1849	90 feet	Price, Neath Abbey	Bristol Channel
Briton Ferry	1852	132 feet	Renfrew	Iron ore
Preston	1853	157 feet	?	Coal/iron ore
Arbutus	1854	180 feet	Toward, Newcastle	Dublin collier
Iron Age	1854	169 feet	Pearse, Stockton	Iron ore
Will o'th Wisp	1854	150 feet	Mitchell, Newcastle	Dublin collier
Isabella Croll	1854	164 feet	Palmers, Jarrow	Coal
Alma	1855	108 feet	Chepstow	Bristol Channel
Annie Vernon	1856	170 feet	Vernon, Liverpool	Coal/iron ore
Thomas Powell	1856	162 feet	Stothert, Bristol	Coal/iron ore
Deva	1857	133 feet	Chester	?
James Kennedy	1857	175 feet	Liverpool	Coal/iron ore
Windermere	1857	175 feet	Poplar	Iron ore
Cuirassier	1860	95 feet	Richardson, Duck, M'boro	China clay
Edmund Ironsides	1860	95 feet	Richardson, Duck, M'boro	China clay
Ibis	1860	255 feet	Pike, Cork	Cardiff-Cork coal
Jessie Brown	1861	102 feet	Barclay, Glasgow	Coal
Morfa	1862	141 feet	Palmers, Tyne	Bristol Channel
Black Diamond	1864	148 feet	Portland, Troon	Coal
Bride	1864	165 feet	Harvey, Hayle	Bristol Channel
Macedon	1864	177 feet	Connell, Glasgow	Coal/iron ore
Norseman	1864	82 feet	Union, Kelvinhaugh	Coal
Vanderbyl	1864	98 feet	Seath, Glasgow	Lundy granite
Agnes Jack	1865	181 feet	Bowdler Chaffer, Seacombe	Coal/iron ore
Bessie	1865	132 feet	Harvey, Hayle	Bristol Channel
Bwllfa	1865	209 feet	Palmers, Newcastle	Cardiff collier
James Garstang	1865	162 feet	Mitchell, Newcastle	Copper ore?
Jane Bacon	1865	170 feet	Bowdler Chaffer, Seacombe	Coal/iron ore
Kirkless	1865	150 feet	Bowdler Chaffer, Seacombe	Dublin collier
Llandaff	1865	153 feet	Schlesinger, Davis, NoT	Cardiff collier
Preston Belle	1865	175 feet	Preston	Dublin collier
Denia	1866	141 feet	Scott, Greenock	?
Dorset	1866	90 feet	Henderson, Renfrew	Bristol Channel
Dublin	1866	174 feet	Walpole and Webb., Dublin	Dublin collier
Fairwater	1866	149 feet	Schlesinger, Newcastle	Collier
Ibis	1866	106 feet	Tod & Macgregor, Glasgow	Iron ore
John Taylor	1866	139 feet	Pile, Spence, W.Hartlepool	Liverpool-Mostyn
Lady Alice Hill	1866	154 feet	Denton, Gray, Hartlepool	Belfast collier
Ogmore	1866	101 feet	Irvine, West Hartlepool	Bristol Channel
Shark	1866	119 feet	Walpole, Dublin	North Wales
St Vincent	1866	141 feet	Stothert, Bristol	Bristol Channel
Aston	1867	100 feet	Schlesinger, Davis; NoT	River Dee

Hayle	1867	147 feet	Harvey, Hayle	Bristol Channel
Lady Alice Kenlis	1867	123 feet	Swan Brothers, Dumbarton	Belfast collier
Lancaster	1867	211 feet	Bowdler Chaffer, Seacombe	Dublin collier
Llewellyn	1867	125 feet	Charlton, Grimsby	Coal/iron ore
Llysfaen	1867	74 feet	Lancaster	North Wales stone
Palermo	1867	138 feet	Swan, Glasgow	?
Tolka	1867	143 feet	Walpole and Webb, Dublin	Dublin collier
Celt	1868	101 feet	Wingate, Glasgow	?
Maggie Ann	1868	125 feet	Murray Port Glasgow	Iron ore
Newport	1868	136 feet	Stothert, Bristol	Bristol Channel
Sea Swallow	1868	82 feet	Thompson, Northwich	Lead ore
Magnet	1869	204 feet	Horn, Dublin	Dublin collier

The table omits a number of vessels which, from their length of under 80 feet and/or Scottish ownership, appear to be Clyde puffers.

Comparing the characteristics of steam bulk carriers

In the only general work on the development of the steam coaster, Waine makes no distinction between these vessels and the east coast collier; indeed, the difference is blurred as all examples given before 1880 are of the latter type.[10] To compare east and west coast bulk carriers, dimensions and ballast capacities of specimen vessels have been compared.[11] Reference has also been made to photographs and to general arrangement and other shipyard drawings of the vessels reproduced by Waine.[12]

Screw colliers are assigned to two groups, those with engines aft and those with engines amidships. Where possible, early colliers have been chosen, as the objective is to examine whether their design influenced that of the west coast bulk carriers.

As table 9.2 illustrates, and is made clear from Waine's classification by size and hull form,[13] west coast ships showed considerable variation in

10. Waine, C.V. and Fenton, R.S., chapter 4.
11. Dimensions and dates from *Lloyd's Register*, *Mercantile Navy List*, and registration documents.
12. Waine, C.V. and Fenton, R.S., and Macrae, J.A. and Waine, C.V., *The Steam Collier Fleets* (Albrighton, 1990).
13. Waine, C.V. and Fenton, R.S., page 11.

size and hull form, and these vessels are discussed in three size bands. Those over 130 feet are known to be of the raised quarter deck type with a bridge amidships and engines aft. Ships are chosen at random to give building dates from 1870s to 1914.

Table 9.3 compares the dimensions, ratios of length to beam and length to depth, ballast arrangements and ballast capacities for two groups of east coast colliers and three groups of west coast vessels. Ballast arrangements are not noted in *Lloyd's Register* for all early colliers, and it has not been possible to discover the ballast capacity of many engines-aft vessels.

East coast colliers: engines aft

Two distinct designs of east coast collier evolved, the engines-aft and the engines-amidships arrangements.

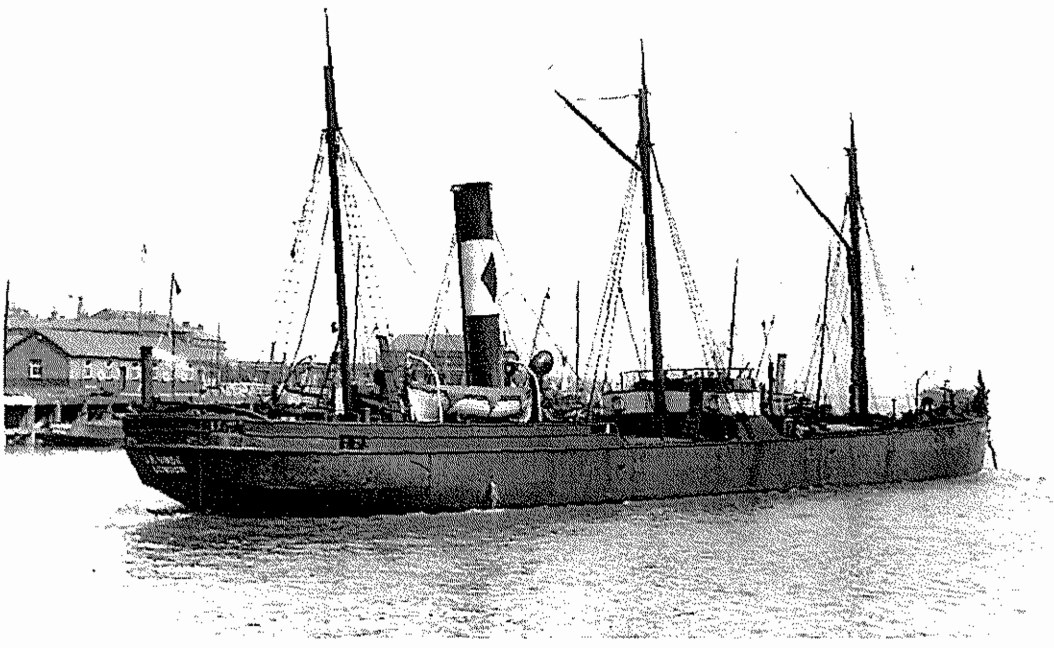

Figure 9.1: the engines-aft east coast collier *J.R. Hinde* built in 1864.

The earliest colliers had engines aft according to plans published by Allan and by Waine[14]: *John Bowes, Lady Berriedale, Black Prince, Firefly, Imperial, Eagle Hawk, Falcon.* They had one or two holds and hatches ahead of the engine room. They were flush-decked, with a rudimentary steering position mounted at the forward end of a low casing around the engine. The colliers were rigged as schooners, and gaffs on the fore and main masts were the only cargo gear fitted. Water ballast arrangements varied, with a combination of McIntyre tanks in the holds and double bottoms gradually replacing the ballast bags originally popular. Ballast capacities are listed in *Lloyd's Register* for only two of the engines-aft colliers in table 9.3, too few to draw conclusions.

As the engines-aft design of collier grew in length, the navigating position was moved forward to between the two hatches. The masts and rigging was retained, with the main mast just abaft of the bridge. The hull aft around the engine was built higher than that alongside the hatches, giving rise to a half-height quarter deck. A forecastle also appears, although it is no higher than the bulwarks which flank the hold, and is only apparent in stern views. The *J.R. Hinde* of 1864 and *Trevethick* of 1866 have this arrangement in photographs taken around 1900.[15] At this date the vessels are still carrying sails.

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14. Allen, E.E., 'On the comparative cost of transit by steam and sailing colliers, and on the different methods of ballasting.' *Proceedings of the Institute of Civil Engineers* XIV (1854-5); Waine, C.V. and Fenton, R.S., chapter 4.
15. Photographs taken by Marcus Barnard of Hull, active about 1900-1920, the negatives being in the collections of Mr John Clarkson and Hull Museums.

In later vessels, the forecastle was raised to a full deck height, and this is evident in photographs of *Upton* (later *Burham*). As she was built in 1865 between *J.R. Hinde* and *Trevethick* and at the same yard, it is likely her forecastle was raised in height at some stage, but later colliers had the full-height forecastle from new.

Two-cylinder simple steam engines were fitted in most colliers built until the early 1870s, with many colliers being either re-engined or compounded in the 1870s and 1880s, *J.R. Hinde* and *Trevethick* being so treated.[16]

East coast colliers: engines amidships

The engines-amidships design of screw collier emerged early, the *Lambton* of 1857 being the earliest known to this design.[17] One hold was ahead of, and one abaft of, the engines.

Lambton was flush-decked like early engines-aft colliers, and this design was perpetuated until at least the *Fenham* of 1868.[18] However, within 12 months the yard which had built *Fenham*, Charles Mitchell of Low Walker, Newcastle-upon-Tyne, had completed the *Hugh Taylor*, a vessel with a raised quarter-deck extending from the navigating bridge about amidships right to the stern.[19] The raised quarter-deck design then became the norm, further engines-amidships vessels having this feature. One reason for the popularity of this arrangement may be that on an

16. *Lloyd's Register*, various dates.
17. Macrae, J.A. and Waine, C.V., page 4.
18. Macrae, J.A. and Waine, C.V., page 20.
19. Macrae, J.A. and Waine, C.V., page 18.

engines-amidships vessel the shaft tunnel reduces the space available for cargo in the after hold. This will lead to the vessel trimming by the head when laden, making steering difficult and increasing draft.[20] Making the after hold deeper by adding a raised quarter-deck increased its capacity, and overcame the trimming problem.

The raised quarter-deck design was enlarged, and colliers such as *Medway* and *Kent* had two holds ahead of the bridge. Later designs also had two holds aft. As table 9.3 shows, the engines-amidships vessels tended to be longer than the engines-aft vessels, but - surprisingly - were on average less deep in the hold. It may be that this sample includes a number of colliers built for the coal trade to Goole, which required shallower vessels than those loading on the Tyne or Wear. [21]

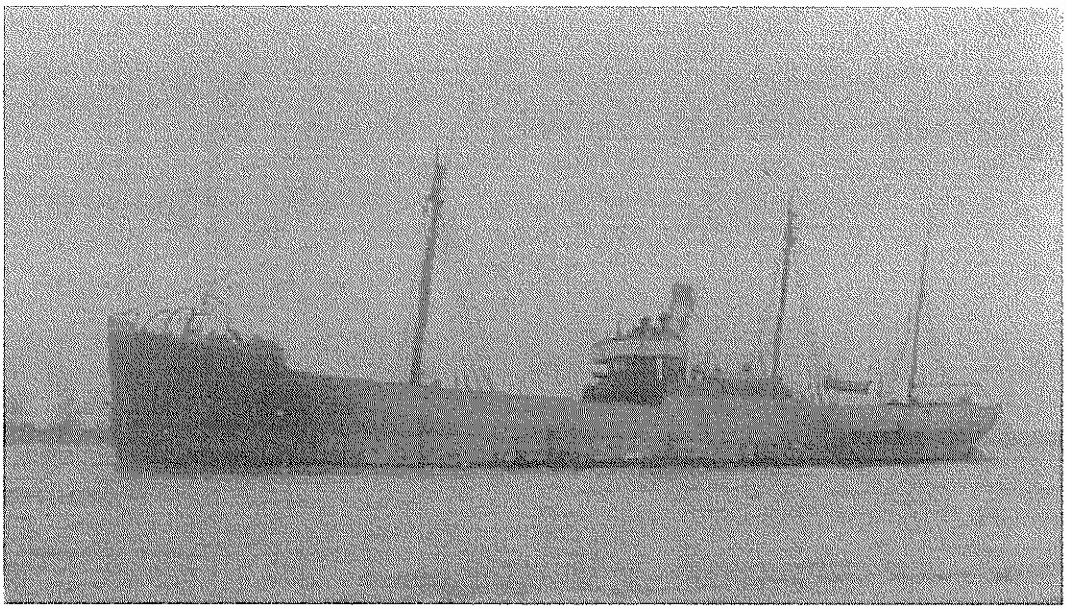

Figure 9.2: the raised quarter-deck, engines-amidships collier *Medway*, 1879

20. Waine, C.V. and Fenton, R.S., page 109.
21. Waine, C.V. and Fenton, R.S., page 106.

Water ballast was contained in double bottom tanks, with only one of the vessels sampled having an aft peak, and none a fore peak tank. This may have reflected the tendency of the vessels to trim by the head.

This type of collier appears to have been the immediate progenitor of the ocean-going steam bulk carrier, the 'tramp' which challenged the sailing ship in deep-sea bulk trades. However, authors writing about tramps have said little about their origins.[22]

The engines-amidships design proved less durable in the coastal coal trade, however. Although ships of this type continued to be built up to and beyond the First World War,[23] the engines-aft design then reasserted its supremacy. The *Fulgens* of 1912, the first collier built for the Gas, Light and Coke Company, was a large vessel, 305 feet long, and had two holds forward of the bridge, and two between the bridge and engines right aft, with a raised quarter deck.[24] This was to be the pattern for coastal colliers until the last steamers were built for the trade in the mid 1950s.[25]

West coast bulkers 80-130 feet

The smallest sea-going vessels in the size range 80 to 130 feet had a single hold served by one or rarely two hatches. A raised forecastle deck and in the larger vessels a poop (it could also be regarded as a bridge deck or quarter deck) improved sea-keeping properties over that of the flush-decked

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22. For instance, Thomas, P.N., *British Ocean Tramps* (Albrighton, 1992).
23. Waine notes the *Cordene* of 1924 as one of last. Waine, C.V. and Fenton, R.S., page 118.
24. From trials photographs taken on behalf of the builder, Wood, Skinner, copies being held by the World Ship Society. *Fulgens* was torpedoed in August 1915: Chesterton, D.R. and Fenton R.S., *Gas and Electricity Colliers* (Kendal, 1984), page 45.
25. Chesterton, D.R. and Fenton R.S., chapters on the North Thames Gas Board and British Electricity Authority.

puffer. The well-deck, between forecastle and quarterdeck, was protected by bulwarks. The only cargo gear was a single derrick on the foremast, usually stepped at the break of the forecastle. A smaller mizzen mast was usually fitted right aft, but was intended mainly to carry a steadying sail (sails were also often rigged on the forestay). The steam engine was aft, with an often rudimentary open wheelhouse forward of this. The seamen and firemen were accommodated in the forecastle, the master, mate and engineer having cabins either in or above the raised quarter deck aft, where there was also a saloon and a galley.

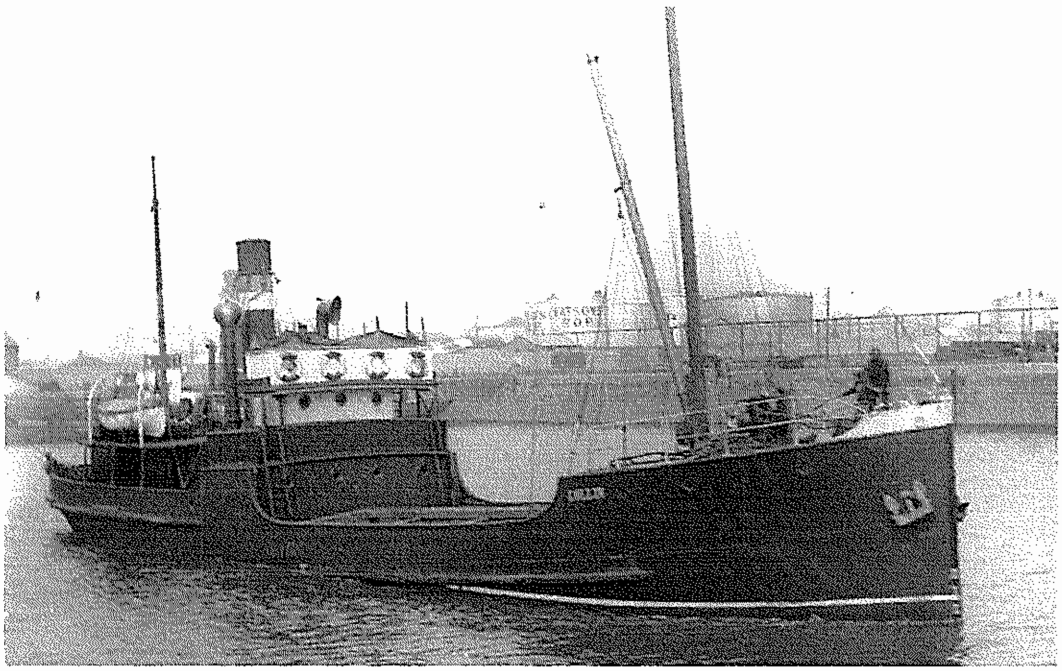

Figure 9.3: the 121-foot *Collin* of 1915.

Once arrived at, this design proved remarkably durable. The earliest of this type for which Waine has a drawing is the *Agate* of 1878. In 1920, in what was amongst the last ships of this size built, the 120-foot long *Doris*

Thomas differed mainly in having a higher forecastle and quarterdeck. The cargo capacity (i.e. deadweight) had been raised from the 210 tons of the *Agate* to 270 tons in *Doris Thomas*, partly by increasing the beam and possibly by making the underwater body of her hull fuller (plans do not allow a direct comparison).

Apart from size, the main feature of these small bulkers which set them apart from the east coast colliers which developed from the *John Bowes* was their arrangements for water ballast. Almost all these small bulkers had modest-sized water ballast tanks fitted in the fore peak (i.e. right forward, below the accommodation in the forecastle) and in a few in the after peak (right aft, usually just ahead of the stern post). None are known to have had double-bottom tanks. The water ballast capacity of the fore peak and aft peak tanks was very modest: just 24 tons on average, about 8-9 per cent of their deadweight capacity. In contrast, Allen's paper in 1855 stated that the east coast screw collier needed to take on ballast equivalent to one sixth, i.e. about 17 per cent, of its cargo capacity.[26] It is likely that in the small west coast vessels, especially those with just fore peak tanks, water ballast was provided merely in order to improve trim when the vessel was sailing light. This would counteract the tendency of a ship which had the weight of its engines aft to ride with its stern much lower than its bow, in which condition steering would be difficult and imprecise.

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26. Allen, E.E., page 328.

Table 9.3 shows that the small west coast vessels were proportionately more beamy than east coast colliers, with a length to beam ratio of 5.8 on average compared with 6.6 and 8.6 for the latter, but the range was large with the ratio for the chubbiest collier (*Caroline*, 5.4) being below that of some west coasters.

The length to depth ratios differed considerably, but the collier was much deeper in the hold: 16.5 feet on average for the engines-aft layout compared with 9.5 feet for the smallest west coast vessel.

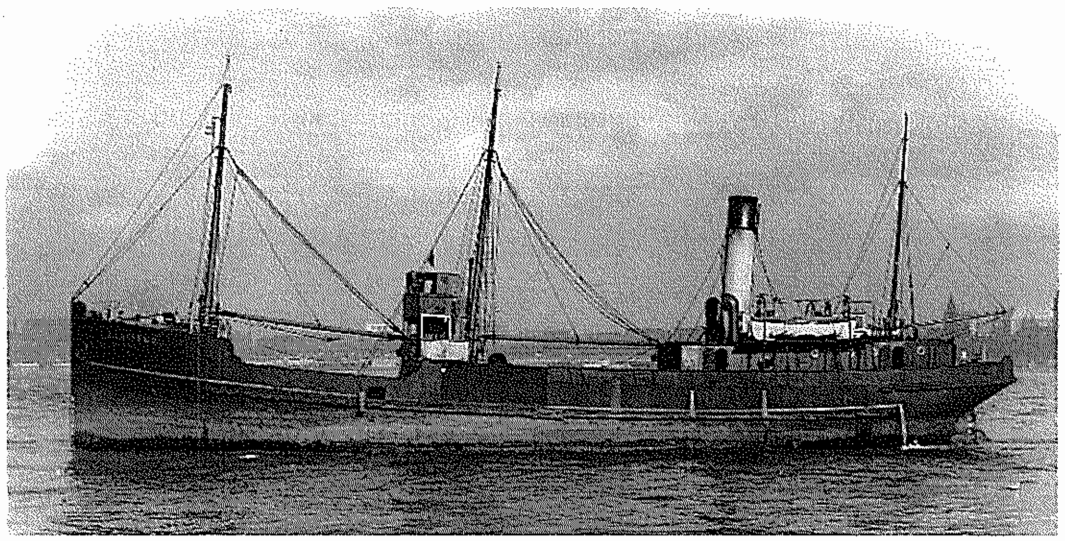
The small coaster and the collier therefore differed not only in length but in their water ballast capacities, that of the small coaster being often less than half that of the collier in proportion to its capacity, and in depth, the collier being much deeper drafted.

<u>West coast bulkers 130-160 feet</u>

For west coast steamerers above 130 feet, the usual arrangement was to have two holds and two hatches. It was normal for the aftermost hold to be one deck higher than the forward hold, so that a raised quarter deck ran from about two fifths of the length aft to the stern. The wheelhouse and some accommodation for master and mate was usually positioned at the forward end of this quarter deck. As in the smaller steamer, there was a forecastle forward, with accommodation for seamen and firemen. The engine was again aft, with accommodation for the engineers and a galley in a deckhouse aft, above the engines. Each of the holds was served by a mast and derrick. Waine has shown that a large number of this type fell in the length band 140 to 150 feet, with 142 feet being particularly popular.[27] This reflected the maximum dimensions of the entrance locks to Ringsend Basin, the main dock used for the coal trade to Dublin.

The smaller bulkers invariably had compound two-cylinder steam engines, it being claimed that the additional economy of triple-expansion machinery was not worth the extra cost and that, in small vessels, the additional cylinder reduced space available for cargo.[28] The larger steamer, the greater the likelihood of fitting a triple-expansion engine, and this machinery was usual in the 142-foot type.

Figure 9.4: *Ashfield*, a 1914-built raised-quarter decker of 143 feet.



The peculiarity of the hull form of these vessels, with a break or 'well' between forecastle and quarter deck requires some explanation. The omission of a continuous deck would add to construction costs and reduce the strength of the hull. A likely explanation is that the raised quarter deck design gave better trimming characteristics. The engine, boilers and

27. Waine, C.V. and Fenton, R.S., page 79.
28. Waine, C.V. and Fenton, R.S., page 35.

bunkers of a 142-foot steamer occupied over a third of its length aft. When the hold was filled with cargo the weight was well forward. The ship would therefore trim by the head, which is undesirable because it made steering less certain, would have allowed the screw to come out of the water in a rough sea, and may have caused draft problems when a loaded ship had to enter or leave a port which, like many ports used by west coast bulkers, had restricted depth of water. The raised quarterdeck design ensured that the hold further aft, which was deeper thanks to the raised quarter deck, took more of the cargo. Placing proportionally more of the weight aft enabled a loaded steamer to trim on an even keel.[29]

The raised quarter-deck configuration became very popular, and virtually all the larger engines-aft vessels on both coasts eventually adopted the arrangement. The raised quarter-deck arrangement was employed on engines-amidships colliers as early as 1869 (*Fenham*, discussed earlier). Paucity of photographs and published plans of vessels built in the 1870s makes it very difficult to state with certainty when the design was applied to engines-aft vessels. The earliest known illustration of this arrangement is of William Robertson's 160-foot *Sapphire* of 1881,[30] a product of the Paisley yard of John Fullerton. This shipyard may have been the pioneer of the design as it certainly went on to build many more of this type, including

29. The author has published this explanation in Fenton, R.S., 'Coastal and short-sea shipping' In: Gardiner, R. (ed), *The Golden Age of Shipping: The Classic Merchant Ship 1900-1960* (London, 1994), pages 81-96, and it has not been challenged.
30. Photograph in the collection of Glasgow University Archives.

several for the west coast owners William Robertson and Richard Hughes,[31] who built up the first important fleets of steam bulkers in the west, but the design was also built by other yards.

As well as a more sophisticated structure, these middle-sized bulkers had greater provision for water ballast, most having a combination of fore peak and aft peak tanks, and in the larger vessels double bottoms as well. The average ballast capacity was 74 tons. Given a deadweight of about 450 tons, the ballast capacity represents 16 per cent of its cargo capacity, a figure regarded by Allen as ideal. A series built at Lytham commencing with the *Ashfield* of 1914 were considered to have a good ballast capacity.[32] *Ashfield's* capacity was modest, at only 39 tons, but later vessels of the series had capacities of around 90 tons in a fore peak, and two aft peak tanks.

Comparison of dimensions and ratios (table 9.3) show that the length to beam ratio in these vessels was increased compared with the smaller coaster (i.e. the vessels were proportionally longer) but was virtually identical with that of the engines-amidships colliers. Again, however, the average depth of 10.8 feet was considerably less than that of east coast colliers (15.2 and 16.5 feet), so that the length to depth ratio was higher for the medium-sized coaster.

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31. Hughes is discussed in Fenton, R.S., *Mersey Rovers* (Gravesend, 1997), pages 84-123. The author's work on William Robertson has not been published.
32. Waine, C.V. and Fenton, R.S., page 79. 'They also had extensive ballast facilities...making for easier passages in ballast.'

Designers of the 130-160 foot west coast bulker were evidently constrained by draft, and this produced a vessel which was little deeper than their smaller cousins, and much shallower in draft than the east coast colliers. Their water ballast capacities tended to be proportionally greater than the smaller ships, but carried in fore peak and aft peak tanks, rather than in double-bottoms which featured only in the larger ships.

West coast bulkers over 160 feet

These vessels were of the raised quarter-deck type, and their layout was similar to the 120-160 feet vessel. There appears to have been relatively little employment for vessels over 180 feet on the west coast in the period up to 1914; no vessels of this size being built for recognised west coast owners in a large series of vessels surveyed by the author.[33]

In eight out of ten vessels of 160 feet and above, double-bottom tanks are fitted, as well as fore peak and often after peak tanks. There was a wide variation in ballast capacities, from 45 tons to 242 tons, the average being 139 tons. Waine estimates their deadweight at 735 tons, so the ballast capacity of these ships is equivalent to 19 per cent of their total cargo carrying capacity.

Table 9.3 shows that the depth of these largest bulkers was very little more, on average, than of those under 160 feet in length: 11.1 feet compared with 10.8 feet. Again, comparisons with east coast colliers show

33. Fenton, R.S., *Mersey Rovers*.

that both the engines-amidships and (even more so) the engines-aft colliers were significantly deeper.

Even for the largest bulkers built for west coast use, therefore, draft was a restriction, and their chief dimensional difference from east coast colliers was a considerably shallower hold. The sparse evidence available suggests these larger vessels had more sophisticated ballast arrangements, comprising fore peak tanks and double bottom tanks.

Table 9.3: Comparison of dimensions of typical east and west coast bulkers of two size bands.

Source: *Lloyd's Registers*, various years 1881-1915. Photographs in the author's collection, and plans published by Waine *et al* have been used to assign vessels to types. All dimensions expressed to the nearest foot.
Abbreviations: DB = double bottom; F = forepeak tank; A = aft peak tank; DT = deep tank

Name	Date	Length	Beam	Depth	L:B	L:D	Ballast
E.C. colliers: engines aft							
John Bowes	1852	149	26	16	5.7	9.3	?
Haggerston	1852	159	25	15	6.4	10.6	DB
Caroline	1853	141	26	15	5.4	9.4	DB -
Lady Alice Lambton	1853	159	17	15	9.4	10.6	?
William Cory	1857	245	35	18	7.0	13.6	DB -
Rouen	1857	204	30	15	6.8	13.6	?
Henry Morton	1860	230	32	18	7.2	12.8	DB -
J.R. Hinde	1864	199	28	17	7.1	11.7	?
Tanfield	1865	203	28	17	7.3	11.9	DB -
New Pelton	1865	180	28	17	6.4	10.6	DB -
Upton/Burham	1865	202	28	17	7.2	11.9	DB 188t
Northumbria	1869	221	28	17	7.9	13.0	DB 200t
Lord Alfred Paget/Eastwood	1870	224	28	17	8.0	13.2	DB -
Average	**-**	**194**	**28**	**16.5**	**8.6**	**10.1**	**-**

Name	Date	Length	Beam	Depth	L:B	L:D	Ballast
E.C. colliers: engines amidships							
Lambton	1857	168	27	14	6.2	12.0	?
Sherburn	1866	187	29	17	6.4	11.0	DB -
Warkworth	1869	160	27	14	5.9	11.4	DB 180t
Fenham	1868	225	29	18	7.6	12.5	DB 211t
Hugh Taylor (RQD)	1869	225	29	18	7.6	12.5	DB 230t
Broomhill (RQD)	1878	175	29	13	6.0	13.5	DB -
Joseph Rickett (RQD)	1879	186	28	14	6.6	13.3	DB 180t
Medway (RQD)	1879	226	31	14	7.3	16.1	DB+A 319t
Kent (RQD)	1881	226	32	14	6.6	13.3	DB 272t
Langdon (RQD)	1882	240	34	16	7.1	15.0	DB 317t
Average	**-**	**202**	**30**	**15.2**	**6.8**	**13.3**	**244t**

Name	Date	Length	Beam	Depth	L:B	L:D	Ballast
W.C. bulkers <130 feet							
Larry Bane	1875	115	20	9	5.8	12.8	?
Agate	1878	121	20	10	6.1	12.1	F 15t
Ada	1880	109	20	9	5.5	12.1	F 12t
Sodium	1887	100	20	8	5.0	12.5	F 20t
Velinheli	1892	95	19	9	5.0	10.5	F ?
James Tennant	1893	120	21	9	5.7	13.3	F 32t
Edith	1900	100	23	11	4.3	9.1	F+A 48t
Calatum	1908	121	22	10	5.5	12.1	F 25t
Saint Modan	1910	122	22	9	5.5	13.6	F+A 21t
Lucena	1913	114	24	11	4.8	10.4	F ?
Collin	1915	121	22	9	5.5	13.4	F+A 25t
Average		**124**	**21.2**	**9.5**	**5.8**	**12.0**	**25t**

Name	Date	Length	Beam	Depth	L:B	L:D	Ballast
W.C. bulkers 120-160 feet *(all raised quarter deck, engines aft)*							
Sapphire	1881	160	23	11	7.0	14.5	F+A 51t
Sylfaen	1883	160	23	11	7.0	14.5	F+A 51t
Primrose	1885	135	20	10	6.8	13.5	F 40t
Moss Rose	1890	150	23	10	6.5	15.0	F+A 60t
Lancashire	1892	160	23	12	7.0	13.3	F+A 55t
Queen's Channel	1894	153	24	9	6.4	17	DB+F 117t
Latchford	1897	160	24	9	6.7	17.8	DB+A 121t
Helmsman	1903	160	25	13	6.4	12.3	DB+F 129t
Inchbrayock	1909	140	24	11	5.8	12.7	?
Ashfield	1914	143	26	12	5.5	11.9	DT+A 39t
Average		**148**	**23.5**	**10.8**	**6.5**	**14.25**	**74 t**

Name	Date	Length	Beam	Depth	L:B	L:D	Ballast
W.C. bulkers >160 feet *(all raised quarter deck, engines aft)*							
Mersey	1891	173	25	12	6.9	14.4	F+A 45t
Brier Rose	1892	165	25	10	6.6	16.5	F+A 70t
Bass Rock	1892	165	26	12	6.3	13.8	DB+F+A 70t
Devonshire	1894	175	27	10	6.5	17.5	DB+F 180t
Fleswick	1899	179	28	11	6.4	16.3	DB+F+A 210t
British Empire	1902	168	27	12	6.2	14.0	DB+F+A 76t
Cheshire	1904	178	29	11	6.1	16.2	DB+F+A 183t
Wheatfield	1909	163	27	12	6.0	13.6	DB+F+A 135t
Primrose	1910	175	28	11	6.3	15.9	DB+F 188t
Allerton	1913	175	28	10	6.3	17.5	DB+F+A 232t
Average		**188**	**27.0**	**11.1**	**6.4**	**15.6**	**139t**

Conclusions

Three major constructional differences between east and west coast bulkers were apparent.

West coast bulkers were built in a much broader range of sizes, from 80 feet up to 180 feet. In contrast, even the early east coast colliers all exceeded 150 feet, and the averages for the two types studied, engines aft and engines amidships, was 194 and 202 feet. This is confirmed by figures in chapter 5, which show that the average length for colliers in service during 1880 was 195 feet, whilst the average for a coaster was 140 feet. Many larger colliers tended to have their engines amidships, whilst all known west coast bulkers had engines aft.

Secondly, the west coast bulker was shallower drafted, with a depth of hold which, even in the biggest vessels of comparable length to the early colliers, was 11.1 feet compared with 15.2 to 16.5 feet for the east coast colliers. This difference is significant, representing about a third of carrying capacity. The shallowness of the west coast bulkers undoubtedly reflected trading conditions, with vessels needing to use a range of ports which typically had less depth of water than those of the Tyne, Wear and Thames habitually used by colliers. This explains the observation that very few east coast colliers were sold to west coast owners for working in their local trades.

Thirdly, facilities for carrying water ballast tended to be less sophisticated in the west coast bulkers, and in the smaller vessels water ballast capacities were small, usually comprising only a small forepeak tank. Medium-sized vessels often had after-peak tanks as well. The fitting of a double bottom became more likely the larger the vessel, with about half of the medium-sized and almost all larger vessels fitted.

A difference between east and west coast vessels can be discerned, but it was one of dimensions rather than constructional differences: the west coast bulker was invariably smaller and had a significantly shallower draft than the collier.

In general, builders of east coast colliers did not go on to build vessels for the west coast, the most successful Tyne and Wear yards preferring to expand into ocean-going cargo ships. It is likely that the development of the steam bulk carrier for use on the west coast from the late 1870s onwards was due in considerable measure to the efforts of Clydeside shipbuilders, probably working closely with pioneering owners such as William Robertson of Glasgow and Richard Hughes of Liverpool,[34] to refine a design better suited than the established east coast collier to local conditions, such as size of shipments and depths of ports.

It is apparent that there was ready and free interchange of ideas on construction: the water ballast arrangements of fore peak and aft peak tanks and, for larger vessels, double-bottom tanks, were taken from the east to the west coast. If the west coast influenced the east coast at all, it was in applying the existing raised quarter deck design to engines aft vessels.

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34. Fenton, R.S., *Mersey Rovers*, pages 84-123.

To answer the question posed in this chapter, there were indeed differences between east and west coast bulk carriers. But they are ones that could be arrived at by builders through simple refinement of existing designs. Building a successful west coast vessel needed no breakthrough in technology, such as the water ballast arrangements in the colliers of the 1850s. However, with significantly lower cargo capacities than east coast colliers, the west coast vessels may not have had the earning capacity to compete economically with sailing vessels until refinements in marine engineering and/or building methods had improved efficiency and reduced costs. Chapter 10 will examine this possibility

CHAPTER TEN: DEVELOPMENTS IN MARINE ENGINEERING AND IRON SHIPBUILDING FROM 1850

In chapter 7 it was established that many steam colliers were operated by those in the coal industry, who accepted modest returns on this investment in order to support other aspects of their activity. It was argued that these early steam colliers were not efficient enough to prove attractive to those who made a living purely from shipowning. Hence, steamers did not quickly spread from coal into other bulk trades, particularly on the west coast, where there were not the equivalent of the London and north eastern coal merchants and owners to invest in them. Chapters 4 and 5 showed that steam bulk carriers began to appear in significant numbers on the west coast only during the decade 1870 to 1880, and chapter 9 confirmed that these vessels were significantly smaller than the screw colliers of the east coast.

It is hypothesised that technology advanced sufficiently between 1850 and the 1880s to make buying and operating steam bulk carriers an economic proposition for those whose living came from shipowning. Further, these developments made it practical to operate profitably the smaller steam bulk carriers which were suitable for the west coast trades. This chapter examines these propositions, looking first in general terms at the changes in industry and technology during the period, and then more specifically at advances in the efficiency of propelling machinery and improvements in shipbuilding.

Sources and methods

The source material for this chapter is relatively rich, although coverage is patchy in some areas - notably the efficiency of the shipbuilding industry in the late nineteenth century. As part of the change in industrial culture in the latter half of the nineteenth century, which saw scientific principles being increasingly applied to manufacturing industry, there was something of an explosion in the literature of marine engineering and shipbuilding. The quality is variable, however. Some books are practical to the point of being no more than workshop manuals, advising on such matters as exactly where to drill rivet holes in a frame. Other books take a wholly theoretical approach, especially to the steam engine, where the discussions of thermodynamics are likely to baffle all but engineers well versed in mathematics and physics.[1] Historical developments are often ignored, probably because the authors wish to deal with the leading edge of technology.[2] A notable exception is a 'Shipping World' publication from the 1880s which not only deals in depth with developments in marine engineering over recent decades, but quantifies the improvements in efficiency achieved in terms of reduced coal consumption.[3]

Modern texts on marine engineering are more helpful in taking a historical perspective. Nevertheless, they tend to showcase the most advanced and ambitious engine room arrangements, usually in the transatlantic liners

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1. Rankine, W.J.M., *Shipbuilding, Theoretical and Practical* (London, 1866) is - despite its title - entirely theoretical.
2. Burgh, N.S. *Modern Marine Engineering* (London, 1872) is particularly disappointing in this respect, as its date of publication puts it right in the period being studied.
3. Anonymous, 'Marine boilers: their construction and maintenance.' *Shipping World Series 2, No. 11.* (London, 1889). This is one of a series of short treatises published by the 'Shipping World'. Most of the other treatises give the author's name, suggesting that the work on boilers is by the journal's editor or a staff writer.

which in the latter part of the nineteenth century represented the leading edge of technology, rather than deal with the less sophisticated but much more typical machinery of cargo carriers.[4]

The shipbuilding literature is plentiful, but contains little material germane to this chapter. Histories have been published of most of the major builders, including Palmers who pioneered collier construction,[5] but these tend to be too broad brush to help identify changes in equipment and methods of working. There has been a strong regional approach to the subject,[6] but most works are not relevant to this study, concentrating more on geographic factors than on the technology employed. An honourable exception is Pollard and Robertson's comprehensive study, but this commences in 1870, and the authors lament that contemporary technical journals devoted little space to the machinery installed in a yard and that this was rarely discussed at meetings of technical societies.[7] This lack of source data is probably the reason that a doctoral thesis by Harley, which sets out to consider technological change in British shipbuilding in the late nineteenth century, concentrates almost entirely on marine engineering rather than hull building. Fortunately the British Shipbuilding Project, one of whose objectives is to catalogue the whole output of British yards building in iron and steel, has identified this gap in studies, and

4. The otherwise excellent Griffiths, D., *Steam at Sea: Two Centuries of Steam-powered Ships* (London, 1997) reproduces many illustrations of machinery in Atlantic liners from technical journals.
5. Despite its title, the Palmers' history, *From Colliers to Battleships*, has little to say on the more humble craft, concentrating as do other histories on the bigger, more prestigious projects.
6. E.g. Ville, S., ed. *Shipbuilding in the United Kingdom in the 19th Century: a Regional Approach* (International Maritime Economic History Association (St. John's, Newfoundland, 1995); Arnold, A.J. *Iron Shipbuilding on the Thames 1832-1915* (Aldershot, 2000); Clarke, J.F., *Building Ships on the North East Coast: Part 1 c 1640-1914*. (Whitley Bay, 1997); Walker, F.M., *Song of the Clyde* (Cambridge, 1984).
7. Pollard, S. and Robertson, P., *The British Shipbuilding Industry, 1870-1914* (Cambridge, Mass., 1979).

two pamphlets by Newman published under the project's aegis have addressed important issues in technological change.

The industrial and technological background

The years after 1850 saw great changes in British industry, especially manufacturing. Starkey points out that in 1850 the great majority of Britain's industrial workers were skilled craftsmen, whilst in 1914 mechanisation and factory organisation had led to the decline of craft skills.[8] The changes in the craft structure of shipbuilding and engineering may have been less far-reaching than in other manufacturing industries. The skills of shipwrights working in wood almost became extinct, but with the change to iron and steel other crafts grew in importance, such as boilermaking, plating and riveting. However, there was almost certainly dilution of the craft content of the shipbuilding labour force. For instance, each plater in a yard building iron ships required at least two unskilled helpers to assist in putting plates into position (including a 'holder-up'), and in the typically unmechanised yards of the period an army of labourers were employed in tasks such as carrying plates to the point where they were to be erected.[9]

Starkey notes that limitations of technique and supply which had afflicted early steamship development were successfully addressed during the third quarter of the nineteenth century.[10] A notable example is the production of iron plates for shipbuilding and boilermaking, the inconsistent quality and high price

8. Starkey, D.B., 'Industrial background to the development of the steamship' in: Greenhill, B. (ed.), *The Advent of Steam: The Merchant Steamship before 1900* (London, 1993), page 129
9. Newman, B., *Plate and Section Working Machinery in British Shipbuilding 1850-1945*. (Glasgow, n.d.); Newman, B., *Materials Handling in British Shipbuilding 1850-1945*. (Glasgow Centre for Business History, n.d.); Clarke, J.F.
10. Starkey, D.B., 'Industrial background to the development of the steamship', page 133.

of which seriously constrained the development of the iron steamship until the 1860s. Harley, in a thesis concerned with shipbuilding in the late nineteenth century and the diffusion of technological change, echoes Starkey's point: 'At any given time techniques in use appear to have been pushing against constraints provided by existing knowledge and skill...'[11] This is exemplified by the search for greater efficiency in marine boilers, which needed improvements in design and manufacturing techniques and in the understanding of physics.

Harley attributes the improvements in marine engineering in the period to an interaction between developing knowledge in thermodynamics and metallurgy and increasing skills and sophistication in metal working.[12] For example, the work of Professor Rankine in the early 1850s gave a clearer understanding of the thermodynamics of the steam engine, and how higher pressures would provide greater efficiency.[13] To put this into practice, however, there had to be advances in techniques of manufacturing iron plates and fabricating them into boilers capable of withstanding high pressures.

The period under review also saw progress in the 'professionalisation' of engineering. The inaugural meeting of the Institution of Engineers and

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11 Starkey, D.B., 'Industrial background to the development of the steamship', page 220.
12. Harley, C.K., 'Shipbuilding and shipping in the late 19th century. A study of technological change: its nature, diffusion and impact.' (Unpublished PhD thesis, Harvard, 1972). This is a particularly interesting source, as the US author is concerned largely with British shipbuilding, which was leading the world in the adoption of metal hulls and steam machinery. He concentrates on the gains in efficiency of steamships brought about by increasing boiler pressures, but pays less attention to factors which improved hull construction, such as developments in shipyard machinery and techniques. Harley also discusses gains in efficiency of steamships primarily on ocean routes in Harley, C.K., 'The shift from sailing ships to steamships, 1850-1890: A study in technological change and its diffusion'. In: McCloskey, D.N. ed., *Essays on a mature economy: Britain after 1840.* (London, 1971).
13. Harley, C.K., 'Shipbuilding and shipping in the late 19th century', page 220.

Shipbuilders in Scotland was held in May 1857,[14] and John Scott Russell - a notable builder of steam colliers - was instrumental in founding the Institution of Naval Architects in London during 1860.[15] Local and national institutions like these were important in encouraging and spreading knowledge of technological developments, and inculcating methods of scientific thought amongst their membership which would result in improved design, materials and working techniques. They were not without opposition, however. Palmer cites a number of examples of practical shipbuilders being opposed to applying scientific principles, and notes that builders of merchant ships largely ignored the Institution of Naval Architects.[16]

Marine engineering developments

Engine and boiler technology tended to develop steadily rather than in major leaps forward, as design, materials and construction methods all needed to improve more or less in parallel. To take just one example, higher boiler pressures needed not just stronger plates, but better methods of joining the plates together. Incremental improvements in each of these aspects need to be considered and this tends to make the overall picture complex. This account will discuss each of the improvements more or less in chronological order, examining how they affected performance and when and if they were applied to the steam bulk carrier, and then summarise how, together, they came to increase efficiency.

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14. Gifford P, in the introduction to *Mirror of History, a Millennium Commemorative Volume*, Institution of Engineers and Shipbuilders in Scotland (Glasgow 2000), pages 11-14.
15 Emmerson G.T. *John Scott Russell: a Great Victorian Engineer and Naval Architect.* (London, 1977).
16. Palmer, S., 'Experience, experiment and economics: factors in the construction of early merchant steamships'. In: Matthews, K., and Panting, G., eds. *Ships and Shipbuilding in the North Atlantic Region*. (St. John's, Newfoundland, 1978), page 238.

Improvements in boilers and engines proceeded in parallel; indeed, they were critically inter-related. Improved efficiency needed higher boiler pressures, and this in turn required advances in engine design such as compounding in order to deliver its full benefit. The more fundamental improvement was in the boiler, and this will be discussed first.

Improvements in boilers

There were essentially three objectives in boiler development: increasing operating pressure; improving thermal efficiency, i.e. transfer of heat from the combustion of fuel to the water; and improving safety by minimising the risk of boiler explosions (which went hand-in-hand with the first objective).

<u>Increasing boiler pressure</u>

The need for increasing operating pressure warrants an explanation. In a marine engine, steam is a medium for conveying the energy released from the combustion of fossil fuel to a point where it can do useful work, i.e. move a piston in a cylinder, which in turn rotates the shaft turning a paddle or propeller. There are major energy losses inherent in this process, including the heat lost in exhaust gases which pass up the funnel; the heat required to turn the boiler water into steam (the latent heat of evaporation); and radiation and conduction losses of heat through the walls of the furnace, the boiler cladding, the pipe work connecting boiler to cylinder, the cylinder walls; and losses in the condenser. These losses mean that the overall efficiency of the steam engine is lamentably low, and in the 1880s an anonymous technical author (probably on the staff of the 'Shipping World') claimed that only 5 per cent of the energy from burning coal could be translated into propulsive power.[17] Improvements in boiler and engine design could reduce the conduction and radiation losses, but not the loss through the need to evaporate water.

Latent heat of evaporation is the energy required to turn liquid water at a given temperature into steam at the same temperature. In molecular terms, it involves putting in energy to break the bonds which hold the water molecules in a liquid form. The latent heat of evaporation is an almost constant amount of energy, varying only to a limited extent with the pressure at which steam is generated. When steam condenses to liquid water, the process is reversed, so that energy is given up by the steam. In a steam engine condensation is achieved by cooling the steam with sea water. The latent heat of evaporation is not regained in the condensing process, but is wasted in that it merely warms the surrounding sea.

For purposes of conveying energy, the useful property of steam (and indeed, any gas) is that it is highly compressible. The more the steam is compressed, the greater the energy stored in it, and hence its expansive power. The more energy which can be stored in the steam, the smaller in proportion will be the loss of latent heat during its generation. Efforts to improve the efficiency of the steam engine therefore concentrated on increasing the pressure at which steam was generated and used.

The 'Shipping World' author gives a worked example.[18] His units of degrees are not ideal, as heat is conventionally measured on the basis of the

17. Anonymous, 'Marine boilers: their construction and maintenance.'
18. Anonymous, 'Marine boilers: their construction and maintenance.'

amount of energy needed to raise a given mass of water by one degree, expressed as calories or joules. 'Sensible heat' is presumed to mean the amount of heat available for raising the temperature of the steam, and therefore theoretically available for turning into propulsive power.

Boiler pressure	**Latent heat**	**Sensible heat**	**Proportion sensible heat/total heat**
60psi	900°	307°	25%
300psi	820°	420°	33%

Despite increases in boiler pressure, the dead loss of energy resulting from the latent heat - energy which 'we cannot grasp' - remained a factor limiting the efficiency of the steam engine throughout its long life.[19]

Improving thermal efficiency

The first boilers which were installed in water craft, for instance in the *Charlotte Dundas* of 1801, were primitive. They were merely cylinders containing water placed on a brick base, which was built so that a series of passageways - the flues - conducted the gases under and around the boiler shell before entering the chimney.[20] Mere 'kettles' Griffiths calls these boilers. Boiler manufacturers developed a variety of designs, but what was regarded as best practice in the 1830s (this type of boiler was installed in Brunel's first and only commercially-successful ship, the *Great Western* of 1837) had a system of flues which were rectangular in cross section and which conducted hot gases from furnace to

19. Anonymous, 'Marine boilers: their construction and maintenance.' The author considered the theoretical maximum pressure for a boiler to be 350psi, at which pressure the temperature of steam would be 430°, close to that at which boiler iron would melt. This pressure figure was later greatly increased (especially in water tube boilers) because the steel which was slowly becoming available in 1880s could withstand much higher temperatures.
20. Griffiths, D., *Steam at Sea*, page 58.

funnel along a pathway designed to ensure the maximum heating surface.[21] The flues were usually large enough for a man to crawl through in order to clean them and make minor repairs. The boiler was of a box shape, a shape which made it relatively easy to fit stays between the sides to withstand the low steam pressures employed, only 5 lbs per square inch (psi) in the case of *Great Western*.

During the 1840s, boiler makers began to move from flues to fire tubes, these being narrower than flues, much more numerous and usually circular in cross section. Fire tubes improved the efficiency of heat transfer by increasing the area of contact between the hot gases and water.[22] In addition, the tubes gave the boiler greater longitudinal strength, supplementing the stays. Tubular boilers were more compact, and so took up less space in the ship's hull.

The standard tubular boiler of the 1840s and 1850s had a bank of tubes which conducted the hot gases from a combustion chamber at the back of the furnace through the water space to a smokebox placed above the fire door on the front of the boiler.[23] Figure 10.1 shows a diagrammatic representation of this return-tube type of boiler, so called because the gases were returned from the back of the boiler to the front.

Evolution of steam collier boilers

A drawing reputed to be of the early collier *Lady Berriedale* of 1852 shows her

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21. Griffiths, D., *Steam at Sea*, pages 58-9.
22. Fire tubes could be too efficient. Anonymous, 'Marine boilers: their construction and maintenance.' describes boilers in which the number and diameter of fire tubes was such that the temperature of the exhaust emerging from the funnel was too low to provide a good draught for the fire. Eventually, this problem was overcome by the use of forced rather than natural draught, but in coastal vessels this was not adopted until the 1920s.
23. Griffiths, D., *Steam at Sea*, page 63.

to be fitted with a box-type, return-tube boiler, typical of practice at the time.[24] This boiler, and those of two other screw colliers completed on the Thames in 1852, *Eagle*, and *Caroline*, had a working pressure of just 12 psi, according to notes made by their builder, John Scott Russell.[25] The 1856-built collier *Nightingale* still had a boiler working at 12 psi, even though considerably higher pressures were being used in boilers being installed in other ships built by Scott Russell. For instance, his paddle steamer *Dieppe* of 1854 had a working boiler pressure of 20 psi, the *El Ray James II* (probably also of 1854) worked its boilers at 22 psi. The *Great Eastern* was built at Scott Russell's yard, and Brunel accepted Scott Russell's design for the ship's paddle engines. Agreed in 1854, this was for a working pressure of 25 psi.[26]

It is clear that early colliers were not fitted with the most technically advanced boilers. However, boilers needed periodic replacement, as at this time they seldom lasted more than five years, and this need for renewal meant shipowners could retro-fit their vessels with new and improved boilers, confident of an improvement in efficiency. The boiler was therefore often more up to date than the engine and hull.

Of particular relevance to the development of the steam collier and

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24. The drawing from Russell, S.J., *The Modern System of Naval Architecture* (London, 1865) is reproduced in Macrae, J.A. and Waine, C.V., *The Steam Collier Fleets* (Albrighton, 1990), page 14. The dimensions given are close to those of the *Lady Berriedale*, built by Scott Russell in 1852, and Macrae and Waine believe it to depict her. However, it is reasonable to question whether the drawing shows *Lady Berriedale* as built. Scott Russell's book was published over ten years after the completion of the collier, and the drawing - in which the ship is not named - may represent an idealised collier, incorporating improvements made over the decade since *Lady Berriedale* had been built. Scott Russell's notebooks give many details of the dimensions of the boilers fitted to his colliers, but it is not possible to deduce their type from these details.
25. John Scott Russell's notebooks are in the Science Museum Library, London. This data is from Notebook 2, reference MS 516/2.
26. Griffiths, D., Lambert, A., and Walker, F., *Brunel's Ships* (London, 1999), page 148.

coaster was the introduction of the Scotch boiler, which dates to about 1862.[27] Scotch boilers incorporated a furnace in which coal was burnt on a grate consisting of a number of firebars (see Figure 10.2). Below this, in the lower arc of the drum-shaped boiler, was a pit in which the ash collected. At the opposite end from the door by which the furnace was stoked was a combustion chamber, partially separated from the furnace by a firebrick arch. This chamber turned the combustion gases through 180 degrees back into a large number of firetubes which were surrounded by the boiler water. As this part of the boiler was above the combustion chamber, the water was heated not only by conduction from the gases passing through the fire tubes, but also by direct convection and radiation from the fire. After passing through the fire tubes, the gases were collected in a flue which exhausted them through the ship's funnel. The cylindrical drum of a Scotch boiler gave the necessary strength to withstand higher pressures, whilst the tube plates at each end of the boiler were supported by some of the fire tubes themselves, which acted as stays.

A boiler of the type shown in figure 10.2 has a heating surface of 925 square feet, compared with the 1,125 square feet of the boilers fitted to *Lady Berriedale*, *Eagle* and *Caroline*.[28] Thus, in a Scotch boiler a considerably greater pressure has been achieved with a reduction in heating surface. The more compact boiler represented a significant saving in space, allowing more space to be devoted to cargo.

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27. Waine, C.V. and Fenton, R.S., *Steam Coasters and Short Sea Traders* (3rd ed. Albrighton, 1994), pages 38-39; Griffiths, D., 'Triple expansion and the first shipping revolution.' In Greenhill, B. (ed.), *The Advent of Steam: The Merchant Steamship before 1900* (1993), pages 106-126.
28. John Scott Russell's notebook 4, Science Museum reference MS 515/4.

The development of higher boiler pressures was held back by the 1854 Merchant Shipping Act which made steamships liable to inspection by the Board of Trade.[29] The inspectors erred on the side of caution, demanding that boilers were hydraulically tested to twice their working pressure, and regarded 25psi as the safe maximum working pressure for use at sea, a figure which was well exceeded by steam engines on land. This was recognised by Alfred Holt who, although coming from a merchant and shipowning background, had served an apprenticeship in locomotive engineering, probably the cutting edge of mechanical engineering at the time. When he entered shipowning Holt began to experiment with a compound engine using steam at 60psi, which was installed in his *Cleator* in 1864.[30] The boiler appears to be closely related to the Scotch boiler.[31] A development of the *Cleator's* boiler, also working at 60psi, was used in Holt's trio of steamers, beginning with *Agamemnon*, which entered service in 1866, inaugurating the Ocean Steamship Company, better though unofficially known as the Blue Funnel Line. Alfred Holt's engine reduced coal consumption to 2.2 lbs per indicated horse power per hour: half that of the *Great Britain* of 20 years earlier.[32]

29. Jarvis, A., 'Alfred Holt and the compound engine.' In Gardiner, R. ed., *The Advent of Steam: The Merchant Ship before 1900* (London, 1993), page 158.
30. Jarvis, A., page 157.
31. Jarvis, A., page 158 includes a drawing of a 'later Holt-type boiler', which is described as being like two *Cleator* boilers back-to-back. They appear identical to Scotch boilers.
32. Corlett, E.C.B,. 'The Screw Propeller and Merchant Shipping 1840-1865'. In Greenhill, B. (ed.), *The Advent of Steam: The Merchant Steamship before 1900* (1993), page 99.

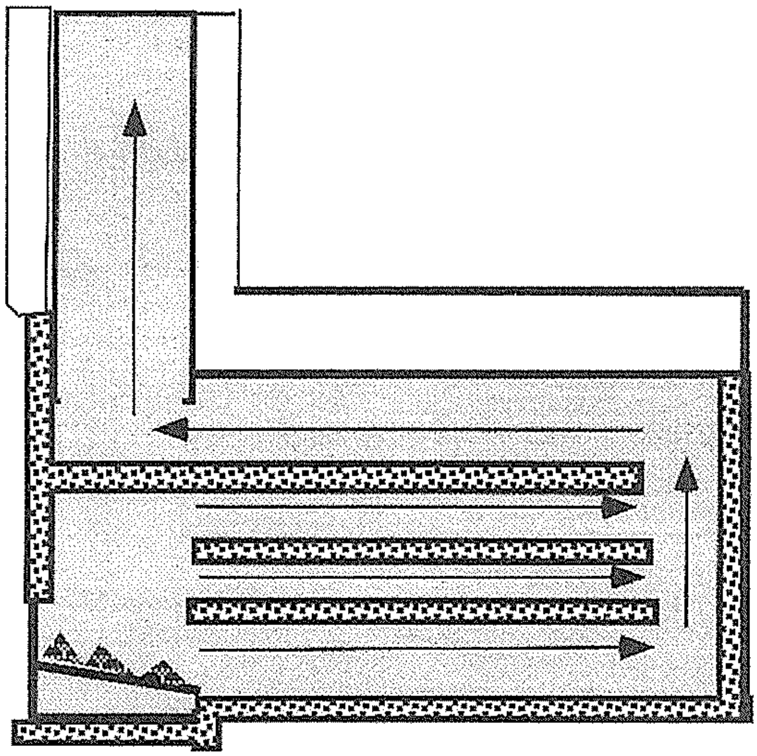

Figure 10.1: Diagrammatic representation of a return flue boiler.

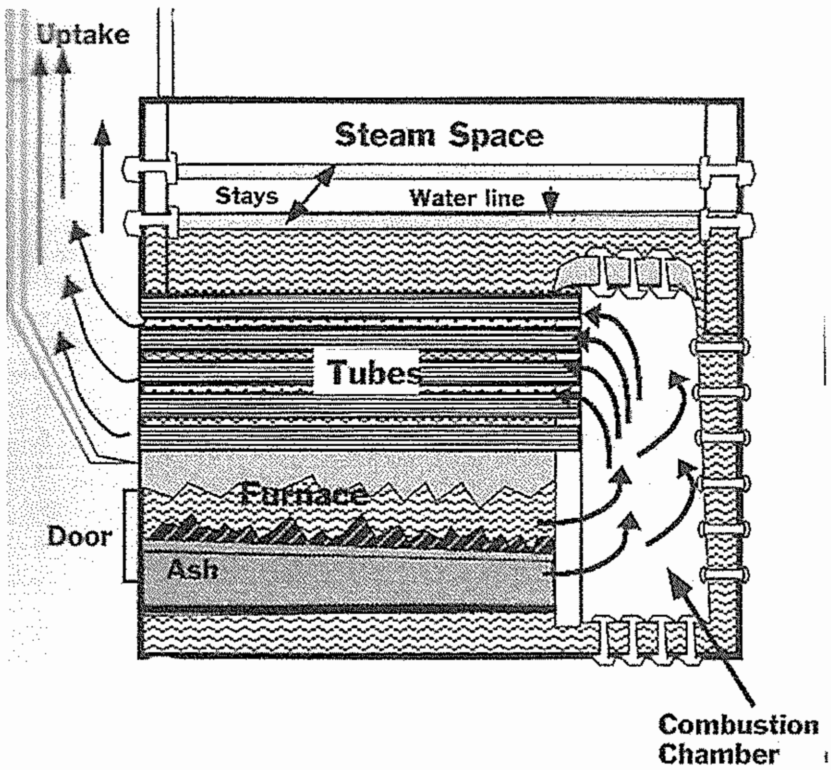

Figure 10.2: Diagrammatic representation of a Scotch boiler.

One of the limiting factors in the ability of a Scotch boiler to withstand high pressures was the strength of its furnace. There was little scope for fitting stays, as was done in the water space, because the rivets would be weakened by the heat. The solution was the corrugated furnace, patented by Samson Fox in 1877, and quickly adopted, so that by the 1880s most boilers had corrugated furnaces to Fox's or similar designs.[33] As with corrugated iron plates, the folds gave additional longitudinal strength.

By 1875, a pressure of 75psi was considered the safe maximum for a marine boiler.[34] But pressures continued to rise, and Stephenson Clark's collier *Gracie*, completed in 1879, had a boiler pressure of 80psi. The description

33. Griffiths, D., *Steam at Sea*, page 69.
34. Griffiths, D., 'Marine engineering development in the nineteenth century' In Greenhill, B. (ed.), *The Advent of Steam: The Merchant Steamship before 1900* (1993), page 171.

published in a contemporary technical journal suggests this pressure was unusually high.[35] In the mid-1870s, *Lloyd's Register* began publishing boiler pressures as part of the technical information given for each ship it listed. Table 10.1 lists the pressures for ten randomly-chosen colliers, either built or re-boilered in the late 1870s, and shows that by then pressures of 70 to 80psi were usual, and 80psi not uncommon. Table 10.2 repeats the exercise for bulk carriers operating on the west coast. Boiler pressures are slightly lower, in the range 60 to 70psi. Colliers and their west coast relatives of this era were therefore keeping up with contemporary marine engineering practice in terms of high boiler pressures.

Table 10.1: Boiler pressures of typical east coast colliers in the late 1870s

Source: *Lloyd's Register* 1880-81

Name	**Built/reboilered**	**Boiler pressure**
Berrington	1865/1876	75lbs
Biddick	1864/1878	65lbs
Blue Cross	1869/1877	70lbs
Contest	1880	75lbs
Erasmus Wilson	1876	70lbs
Fenella	1870/1878	77lbs
Gracie	1879	80lbs
Laffitte	1877	70lbs
Nerissa	1877	80lbs
Shoreham	1872/1879	80lbs

35. *The Marine Engineer*, June and July 1883, quoted by Macrae and Waine, page 51.

Table 10.2: Boiler pressures of typical west coast bulk carriers in the late 1870s

Source: *Lloyd's Register* 1880-81

Name	Built/reboilered	Boiler pressure
Agate	1878	70lbs
Amethyst	1870/1880	60lbs
Ardclinis	1870/1880	70lbs
Captain McClure	1876	65lbs
Eglinton	1877	70lbs
Elagh Castle	1879	70lbs
Emerald	1879	70lbs
Galgorm Castle	1879	70lbs
Saxon	1879	70lbs
Tolfaen	1877	70lbs

Attempts to increase boiler pressure dramatically saw water tube boilers being designed, in which the hot combustion gases passed around tubes containing water - the reverse of the traditional, fire-tube boiler. Such boilers working at pressures as high as 150psi were tried in 1874, albeit unsuccessfully, to provide steam for the triple-expansion engines in the *Propontis*.[36] Leakage and corrosion of tubes quickly ensured that such boilers remained experimental, and it was many years before water tube boilers became a viable proposition for merchant ships,[37] and none are known to have been fitted in colliers or other steam bulk carriers built up to 1914 (in fact, the first was probably fitted in a coastal collier in the 1950s).

Conventional fire tube boilers working at 120psi were successfully used in the 1874-built *Sexta*. The anonymous 'Shipping World' author, writing in the late 1880s, discusses double-ended, cylindrical, tubular boilers - Scotch boilers

36. Griffiths, D., 'Triple expansion and the first shipping revolution', page 107.
37. Griffiths, D., *Steam at Sea*, page 70.

with furnaces at both ends - working at 150psi as if they were normal contemporary practice.[38]

Advances in boiler pressures also required progress in methods of constructing boilers. The introduction of hydraulic riveting made boilers stronger, and presumably quicker to build. The major constructional change was the introduction of steel, which became more readily available and cheaper with developments in the open-hearth furnace method of smelting iron in the 1870s. It has been claimed that, by the mid 1880s, most boilers were constructed of steel.[39] Steel was stronger, weight for weight, and withstood higher steam temperatures, which in turn permitted higher working pressures. The advantages of steel are discussed more fully in the paragraphs on hull building below.

By the late 1880s, the development of boiler design for small merchant ships was almost complete. A steel Scotch boiler with corrugated furnaces and working at a pressure of 150psi was now (and remained) the usual equipment of the collier or coaster.[40] With some improvements in detail, and further modest increases in working pressure, the Scotch boiler proved remarkably long-lived, and - looking well beyond our time frame - saw out the life of the steam coaster and collier. The last steam colliers built for the east coast coal trade in the 1950s had boilers working at 220psi.[41] Thus, in the three decades from their introduction, the boiler pressures of screw colliers had risen from 12 to 150psi.[42]

Boiler development was characterised not just by increases in pressure

38. Anonymous, 'Marine boilers: their construction and maintenance'; Griffiths, D., *Steam at Sea*, page 70, endorses this view.
39. Harley, CK. 'Shipbuilding and shipping in the late 19th century', chapter 7.
40. Griffiths, D., *Steam at Sea*, page 70.
41. Waine, C.V. and Fenton, R.S., page 120
42. Anonymous, 'Marine boilers: their construction and maintenance.'

and consequent greater economy. The improved boilers also represented 'a very large diminution of weight and space required for a given pressure.'[43] The decreasing size of boilers improved carrying capacity and reduced weight. Installing a smaller boiler meant that, with no increase in hull size, more space could be devoted to a paying cargo. It also meant that a given quantity of cargo could be carried in a smaller and perhaps shallower hull, which was less expensive to build and maintain, and could use a wider range of smaller ports, harbours and waterways - a very important consideration in the coasting trade.

Improvements in engine efficiency

As with boilers, improvements in the efficiency of engines came through a number of developments in the design of machinery and ancillary equipment. It was thus made at a steady rather than a spectacular pace.

Development of an engine for screw propulsion

The earliest marine engines drove paddle wheels, and were designed to turn at a relatively slow speed to suit the rotation of the paddle wheel. For efficiency, the screw had to be driven at a higher speed, at least 60 rpm compared with 20 rpm for a paddle steamer.[44] Various methods of achieving an increase in shaft were tried, including gearing on the *Archimedes* of 1840 and chain drive on Brunel's *Great Britain* completed in 1843.[45] Gearing was simpler to construct, and was technically successful, but introduced the extra expense of gears (which were difficult to cut and wore out alarmingly quickly), which were also

43. Anonymous, 'Marine boilers: their construction and maintenance.'
44. Waine, C.V. and Fenton, R.S., page 34
45. Griffiths, D., *Steam at Sea,* page 34.

noisy (Brunel's reason for chain drive) and reduced efficiency through frictional losses.[46] Direct-drive engines were therefore desirable.

At the time of the earliest screw steamers in the 1840s, the typical machinery was an oscillating engine which had the piston rod attached directly to the crankshaft, with the cylinders oscillating from side to side. This obviated the need for complex valve gear, for the admission and exhaust ports were covered and uncovered as the cylinders moved. However, the increase in rotational speed required to directly drive a screw meant that the vibration associated with oscillating cylinders became unacceptable.

Several different designs of engines were tried, including beam engines, which had a massive beam mounted above the vertical cylinder from which the drive was taken to a gear wheel connected to the screw shaft.[47] Horizontal screw engines, with the cylinders placed across the ship, were built for the *Great Eastern* in 1854 and some warships,[48] but were only feasible in ships of considerable breadth. None of these were mainstream developments, however, and it was the inverted direct-acting engine which became almost universally employed in coastal and indeed most other cargo-carrying screw steamers.

The inverted engine may have been produced as early as 1846 by Caird and Co. for the coastal steamer *Northman*, but details of this are sparse,[49] and it was not produced in quantity until the 1850s. 'Inverted' referred to the placing of the cylinders above rather than below the crankshaft, as had been the norm

46. Griffiths, D., *Steam at Sea*, page 37.
47. Griffiths, D., *Steam at Sea*, page 36.
48. Griffiths, D., *Steam at Sea*, pages 37-38.
49. Griffiths, D., *Steam at Sea*, page 39. Thompsons on the Clyde are credited with popularising this type of engine.

in paddle steamer engines. The cylinders (usually two) were attached vertically and in line astern to a heavy casting known as the bedplate which also supported the bearings for the crankshaft. Piston rods from each cylinder passed through the lower cylinder cover and were attached to a crosshead, from which a connecting rod transmitted the power to turn the crankshaft. Unlike the oscillating engine, some form of valve gear was necessary, this usually being placed between the two cylinders. The advantages of the inverted (or as it was sometimes known, vertical) engine were compactness plus a simple, robust design that was relatively easy to fabricate, maintain and to develop. Indeed, the basic layout of this engine was largely maintained throughout the long lifetime of the cargo-carrying steamship.

The early steam colliers did not have the most technically advanced machinery. The screw collier arrived before the inverted engine had become established, and early examples were fitted with a variety of machinery types. *John Bowes* was built with two single-cylinder engines fitted side by side and geared to a single shaft; this arrangement lasting until 1864 when the pioneer collier was fitted with a two-cylinder inverted engine.[50] *Haggerston* is described as having a two-cylinder direct-acting engine, but no further details are known.[51] *Lady Berriedale*, the third steam collier, completed in 1852, had a two-cylinder oscillating engine[52] and the later products of Scott Russell's yard -

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50. Macrae, J.A. and Waine, C.V., page 13. No source is given for this data, and the surviving author (Waine) is not aware of its origin.
51. Macrae, J.A. and Waine, C.V., page 14, quoting from a Government report on the state of the merchant marine.
52. A drawing of a 'water ballast steamer' reproduced as Plate 4 in Allen, E.E., 'On the comparative cost of transit by steam and sailing colliers, and on the different methods of ballasting.' *Proceedings of the Institute of Civil Engineers* XIV (1854-5), following page 348, is thought by Waine to illustrate

Eagle, *Caroline*, *Falcon* and *Hawk* - probably had similar machinery. Details of engine types for other colliers from the 1850s are unknown, as such information was not routinely recorded in registration documents until the 1860s, and even later in *Lloyd's Register*.[53] Details found for the colliers built in the 1860s invariably show they had two-cylinder inverted engines.[54]

<u>The surface condenser</u>

Unlike steam railway locomotives, most marine steam engines were fitted with a condenser to turn the steam exhausted from the cylinders back to water. The condenser improved efficiency, as the lower the temperature of the exhaust, the more energy is extracted from the steam as power for the engine. With early condensers a jet of sea water was played on the steam whilst a pump created a modest vacuum in the condenser. The condensate was collected in a hot well and returned to the boiler. As this process was repeated, salt from the sea water accumulated in the boiler, its build up reducing the transmission of heat to the boiler water. It became the practice to periodically 'blow down' the boiler, opening a valve in the bottom to run off the saline solution, but this was wasteful of heat.[55] The salt in the boiler water also contributed to corrosion, hydrochloric acid forming at temperatures achieved with a boiler working at a

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Lady Berriedale, and clearly shows her oscillating engine. The notebooks of Scott Russell, builder of the *Lady Berriedale*, are rich in costs, dimensions and other details of his ships, but give no clue to the engine design.

53. Very few if any early colliers were classed by Lloyd's Register, whose surveyors were initially very distrusting of iron ships. This meant that the ships' engine details only appeared in the Society's register books from the 1880s, when competition from Bureau Veritas encouraged Lloyds to list all ships over a certain modest tonnage, whether classed by them or not. Even then, for non-classed ships, engine details can be sparse, Lloyd's Register not having detailed records of these ships.

54. Data from registration documents in Classes BT108, BT110, and CUST 130 in the National Archives. Data on colliers from these and other sources appears in appendix 2. Macrae, J.A. and Waine, C.V., pages 18 and 20 includes drawings of colliers from the 1860s which clearly show this type of engine.

55. Waine, C.V. and Fenton, R.S., page 35.

pressure as low as 15psi.[56] The corrosion was intensified by the breakdown of the fatty acids used in contemporary lubricants. Not surprisingly, the life of a boiler working with a jet condenser was only four or five years. The problems of corrosion and the need to blow down the boiler periodically militated against adoption of high boiler pressures.

The surface condenser patented by Samuel Hall in 1834 offered a solution to these problems, although it was many years before problems with materials and construction were solved and the design was universally adopted.[57] The surface condenser allowed the boiler water and the cooling sea water to be kept rigorously apart, the latter being pumped through a nest of brass tubes whilst steam was admitted to space around the tubes and condensed on their cold surfaces.[58] Thus, boilers could use entirely fresh water, with only a small quantity needing to be carried to offset losses due to steam leaks or to the safety valves blowing off. Contamination with lubricating oil and its breakdown products still occurred, and indeed the problem actually increased: with the boiler water no longer needing to be blown off and topped up, the contaminants built up. Early enthusiasm for surface condensers soon evaporated, and they had fallen out of use by the time the first steam colliers were built. It was not until the 1860s and 1870s that the problems with surface condensers were overcome, by filtering the water to remove oil before returning it to the boiler, by use of lubricants that did not breakdown so readily, and the availability of chemicals to treat boiler water. Hence, it was not until

56. Harley, CK. 'Shipbuilding and shipping in the late 19th century', page 224.
57. Griffiths, D., *Steam at Sea*, page 13.
58. Waine, C.V. and Fenton, R.S., pages 35-36.

30 years after Hall patented his surface condenser that his invention began to deliver the benefits it promised.

Multiple-expansion engines

One of the reasons for the longevity of the inverted engine design was its suitability for adaptation to compounding.[59] Indeed, some engines may have been physically adapted to compound working, as registration documents and register books refer to the engines of certain early colliers being compounded, rather than the vessels being re-engined. The compound engine used the expansive power of steam in two stages, to move first a high- and then a low-pressure cylinder. Patented in 1853,[60] compounding was first used in the *Brandon*, in 1854.[61]

Compounding was a necessary step in employing higher steam pressures. A high degree of expansion was theoretically possible in a single-cylinder simple engine, but in practice the heat losses were severe.[62] Maximising the efficiency of a steam engine required the difference between the temperatures of steam generated in the boiler and of the condenser to be as great as possible.[63] However, large temperature differences led to equally large losses of heat when the steam entered the cylinder. The compound engine reduced these losses by expanding the steam in stages. Steam from the boiler first entered the high-pressure cylinder and expanded to a certain pressure and

59. Griffiths, D., *Steam at Sea*, page 40.
60. Starkey, D.B., 'Industrial background to the development of the steamship,' page 133.
61. Craig, R., *The Ship: Steam Tramps and Cargo Liners 1850-1950* (London, 1980), page 11.
62. Corlett, E.C.B., page 98.
63. Roberts, J.K., *Heat and Thermodynamics*, cited by Harley, C.K., 'Shipbuilding and shipping in the late 19th century. A study of technological change: its nature, diffusion and impact. Unpublished PhD thesis, Harvard 1972.

temperature, pushing out the piston. Valves then admitted this steam without significant change of pressure or temperature to the second or low-pressure cylinder where it expanded further until it reached the temperature of the condenser. The individual cylinders in a compound engine worked at a narrower range of temperatures and pressures than the single cylinder in a simple engine using steam at the same pressure. The smaller temperature range reduced heat losses, although at the cost of some minor losses of energy as friction when the steam passes through the valves between cylinders.

In the *Brandon* boiler pressure was around 30psi, and coal consumption about 3¼lbs per indicated horse power (IHP) per hour, compared with 4-4½lbs per IHP per hour in her most economical predecessor. Compounding achieved a reduction in fuel consumption of some 30-40 per cent,[64] with an approximately 20 per cent increase in first cost of the engine.[65] It has been suggested that the introduction of compounding was encouraged by the 'coal famine' of the 1870s, which saw the price of Welsh steam coal double between 1871 and 1873.[66] However, this famine was a temporary phenomenon, and by 1876 the price had fallen to its 1871 level and then continued to drop. Introduction of compounding was one of the major factors which allowed working pressures to increase steadily, from an initial 30psi, to 40psi in the 1860s after the general adoption of the surface condenser, to 60psi by 1866 and 70psi by the mid-1870s.[67]

64. Craig, R., page 11.
65. Harley, C.K., 'Shipbuilding and shipping in the late 19th century', page 229.
66. Harley, C.K., 'Shipbuilding and shipping in the late 19th century', chapter 7.
67. Craig, R., page 11.

The first record found of a compound engine being fitted into a new collier is in 1870, when several were completed with this type of machinery[68] and thereafter most new buildings had compound engines. The same year conversions and replacements of older machinery began, the first record found is of the *Upton*'s simple inverted engines, which were no more than five years old, being altered (or replaced, it is not clear which) in 1870.[69] By early in the 1880s, almost all of the older colliers had received compound engines. One of the last was the *John Bowes*: the replacements fitted in 1883 being her third set of machinery.[70]

With further increases in boiler pressure, the logical development was to move from the two-stage expansion of the compound engine to the triple-expansion engine, which had high-, intermediate- and low-pressure cylinders. Again, the design of the inverted engine proved very adaptable, it being simply a matter of adding a third cylinder in line with the others. The first triple-expansion engine was designed as a matter of necessity to make best use of steam at the then high pressure of 150psi, specified by the owner of the steamer *Propontis* being built by Elders on the Clyde in 1874.[71] The water-tube boilers in *Propontis* proved disastrous, but Elder's engine designer, A.C. Kirk, realised that similar high pressures could be developed in the much more reliable Scotch boilers. He persuaded other shipowners of the economies of triple expansion (when working, *Propontis* gave coal consumption figures of

68. An early example was Doxford's *Amy*; registration documents in National Archives, CUST130 series.
69. Data from contemporary *Lloyd's Register*.
70. Data from contemporary *Lloyd's Register*.
71. Griffiths, D., 'Triple expansion and the first shipping revolution,' pages 106-126; Griffiths, D., *Steam at Sea*, page 98.

1.3lbs/horsepower/hour), and the first successful application was in the *Aberdeen* of 1881. As with superheating, the economies produced by triple-expansion engines were not immediately realised in the coastal trade, this type of machinery not being generally adopted by larger bulk carriers until the 1890s, and never succeeding in replacing the two-cylinder compound in smaller steamers.[72] The logical progression, the quadruple-expansion engine, was developed but was only worthwhile for relatively large vessels, and no examples have been found amongst coastal colliers or bulk carriers.

Other improvements to engines

Superheating or steam drying, to raise its temperature well above the boiling point of water, has the potential to improve efficiency in the same way as increasing boiler pressure. Superheated steam has greater expansive power and a lesser tendency to condense to water in the cylinders. Apparatus for steam drying had been devised as early as 1827, but superheating was not generally applied until the 1860s.[73] A saving of about 20 per cent could be obtained by raising the temperature of steam at 20psi by 100°F.[74] However, when boiler pressures reached about 60psi, problems were encountered, as the high steam temperatures of around 400°F achieved decomposed the animal and vegetable fat lubricants then available (usually tallow). Without effective lubrication, wear of cylinders, pistons and valves became excessive, and were not compensated for by fuel savings. Experiments with superheating were abandoned until about 1900 when better mineral-oil based lubricants had been developed. Even then,

72. Waine, C.V. and Fenton, R.S., page 35.
73. Griffiths, D., *Steam at Sea*, pages 63-64.
74. Griffiths, D., *Steam at Sea*, pages 63-64.

only the engines of large vessels were fitted, and superheating did not spread to coasters until the 1920s.

Throughout this period engines improved in efficiency through better technology and metal working skills. Closer tolerances gave tighter joints, and with better cylinder packing steam losses were reduced.[75] Improved bearings, superior lubricants, better balancing of moving parts - all reduced frictional losses. Developments in materials technology and methods of construction and better understanding of stresses allowed weight to be reduced, especially of moving parts. An example was the lengthening of the rod which connected piston and crankshaft, encouraged by the availability of better and cheaper iron.[76] Lengthening this rod meant the piston could be positioned further from the crankshaft. This in turn allowed a longer piston stroke, so that the cylinder could be longer and narrower and yet give the same swept volume - such cylinders being cheaper to fabricate.

Gains in efficiency

Two independent assessments are in broad agreement that spectacular improvements in efficiency were achieved over the three decades following the introduction of steam colliers in 1852. The anonymous 'Shipping World' author states that Scotch boilers of 150psi typical of the 1880s gave a fourfold reduction in coal consumption compared with boilers from the 1850s, from 6lbs to 1.5lbs/hour/horsepower.[77] Harley, in an assessment as

75. Harley, C.K., 'Shipbuilding and shipping in the late 19th century', page 223.
76. Seaton, A.E., 'Progress in marine engineering in the mercantile marine' *Transactions of the Institute of Naval Architects*, 1892, **XXXIII**, pages 74-80.
77. Anonymous, 'Marine boilers: their construction and maintenance.'

part of his study of changes in shipbuilding technology, estimates the improvements from 1855 to 1885 as 5lbs to 1.7lbs/hour/horsepower, a threefold gain in efficiency (see Figure 10.3).[78]

Although the 'Shipping World' author cites boiler improvement as the reason for the gains, it is impossible to separate the economies achieved through higher pressure boilers and those gained through building more efficient engines. The two were complementary, and the three- to four-fold measures of improved fuel efficiency must be understood as an achievement of both boiler and engine designers. Less well documented than gains in economy, but also relevant to a shipowner, improvements in engine and boiler design and construction improved reliability, increasing the time a ship was working for its living.

78. Harley, C.K., 'Shipbuilding and shipping in the late 19th century,' figure 7.1, page 218.

Figure 10.3: Coal consumption of marine steam engines per indicated horsepower per hour 1855-1890

Source: Harley, C.K., page 218. This figure is based on Harley's reading of papers by Bramwell, Marshall and Blechynden in the *Proceedings of the Institution of Mechanical Engineer* (see Bibliography)

Developments in hull building

Developments from 1850 in the materials, skills and technology used in iron and later steel hull construction delivered a more efficient, economical and reliable ship to the owner. During the period use of iron in shipbuilding grew fast, eclipsing wood in terms of the tonnage launched from British yards around 1863.[79] By 1871, 90 British yards were building in iron, employing almost 5,000 men.[80]

Costs and quality of iron

Production of iron grew massively during the middle years of the nineteenth century: from 1.24 million tons in 1839 to 6.4 million tons in 1875.[81] Factors included the increase in sizes of furnaces, and new methods of iron production, such as the introduction of regenerative hot blast in 1860. Importantly for the shipbuilder, quality improved through better quality control and the cost of iron fell. Harley quotes prices for iron taken from trade journals of the period and from the records of shipbuilders Denny of Dumbarton and Alexander Stephens of Linthouse, and finds an overall fall from £10 per ton in 1855 to a low of £5 per ton in 1886 (about the time steel replaced iron), after which there was a short-lived rise (his series ends in 1890).[82] Allowing for other factors (the other major input determining price was shipbuilding wages, which rose by about 50 per cent overall during this

79. Starkey, D.B., , page 134; Pope, R., *Atlas of British Social and Economic History Since c.1700* (New York, 1989), page 49 gives the date as 1862.
80. Pope, R., page 51.
81. Pope, R., page 46.
82. Harley, C.K., 'Shipbuilding and shipping in the late 19th century,' figure 5.2, page 89.

period) Harley considers the decline in iron prices to have reduced shipbuilding costs by about 20 per cent.

The adoption of steel

Steel became a major competitor to iron in the 1860s with the development of the Bessemer converter and the open hearth furnace,[83] but it was some years before it could compete on price with iron for shipbuilding. The replacement of iron by steel for hull and boiler building then took place over a relatively short period, at least by comparison with the speed other improvements such as mechanisation were adopted by the shipbuilding industry. For example, Denny of Dumbarton began building in steel in 1878 and by 1883 had completely abandoned iron. In the industry as a whole over 90 per cent of ships were stll built of iron in 1881 but growth in steel shipbuilding was then so strong that it overtook iron in 1884-85.[84] There are suggestions that the change was not geographically even: yards on the Clyde adopted steel earlier than their rivals on the Tyne and Wear because there were steel plate manufacturers in the west of Scotland but not in the north east of England.[85]

Steel was stronger, weight for weight, than iron, and its adoption meant that 15 per cent less metal was required in the average hull.[86] This did not immediately give a proportionate cost reduction, as steel began to be adopted as soon as its price dropped to within 15 per cent of iron, but as

83. Pope, R., pages 46-47.
84. Harley, C.K., 'Shipbuilding and shipping in the late 19th century,' chapter 2.
85. *Engineering*, 1st September 1882, cited by Pollard, S. and Robertson, P., page 259.
86. Harley, C.K., 'Shipbuilding and shipping in the late 19th century,' chapter 2.

steel prices continued to fall economies were achieved. The move to constructing hulls from steel became an important factor in achieving economies in coastal steamers during the latter part of the period under review.

The efficiency of shipyards

Iron shipbuilding was highly labour intensive, and there was considerable scope for improving efficiency through mechanisation. The three areas where efficiencies could be realised were in moving plates and frames about the yard and into position on the growing hull, in cutting and forming the ironwork and especially the hull plates, and in riveting the iron work. There is, however, little evidence that major economies were actually achieved, certainly in the period from 1850 to 1880.

Newman looked at materials handling in shipyards from 1850 and concluded that there was no dramatic progress in shipyard handling of materials to 1900.[87] Much of the work remained manual, with horses being used to move the heavier materials around the yard,[88] and pole derricks of limited capacity being used to hoist iron work for hull construction.

Two reasons are cited by Newman for the reluctance of shipbuilders to invest in handling machinery, one physical and the other financial. Shipyards needed to extend their berths as the size of ships increased, and in

87. Newman, B., *Materials Handling in British Shipbuilding 1850-1945*. (Glasgow Centre for Business History, n.d.).
88. But not the very heaviest loads. Newman quotes an example of two particularly large boilers being moved to a fitting-out berth through a major Clydeside yard. There were problems obtaining enough horses, and concerns about controlling them, so a team of 600 men was used to haul the vehicles carrying each boiler, an operation that took two hours for each. It is an almost biblical image, but this was a major yard at the height of Clydeside's reputation as the world's leading shipbuilding region. Newman, B., *Materials Handling in British Shipbuilding 1850-1945*.

many areas such as in Glasgow and along the Tyne and Wear there was simply no room to expand the boundaries of the yard. Hence, there was often limited space between berths in which to add craneage. Vertical pole derricks of limited lifting capacity, and often hand-powered, were the only pieces of machinery which could be added without taking space from adjacent berths. The second, and probably more significant, factor was the shipbuilders' strong awareness of the extreme cyclical nature of the industry. They were reluctant to invest heavily in capital equipment which, during a downturn in orders, would be under-employed. Manual labour, in contrast, was flexible: it could simply be hired and dismissed as the order book grew or contracted. Indeed, its supply could be attuned to demand almost on a day-to-day basis. Pollard and Robertson contrast this situation with that in overseas yards of the period, which were often better equipped. They conclude that such yards often rued their investment during periods of depression, and do not believe that low investment was a debilitating factor in British yards, with their ready supply of skilled and unskilled labour.[89]

The introduction of steel plate in the 1880s did lead to acceleration in the adoption of handling machinery in the latter part of our period. Unlike iron plate manufacturers, those producing steel imposed virtually no limits on the size of plates. Shipbuilders, anxious to reduce the number of joints needed between plates, willingly embraced larger plates. The weight of an iron plate 10 x 3 feet in 1850 was 0.5 ton; by 1905 the typical steel plate

89. Pollard, S. and Robertson, P., chapter 6 and particularly page 129.

was 36 x 7 feet and weighed five tons.[90] The price for reduced for riveting was investment in machinery to lift and carry the bigger steel plates.

The situation with plate and other iron working machinery has also been reviewed by Newman, although he does not look at the evolution of the equipment in the way he did with materials handling machinery.[91] His view is that there were continuous, but relatively small, adaptations and improvements throughout the period from 1850 to 1914. Again, this was most marked after about 1880 and the advent of steel. Prior to this the only machinery available had been steam driven, and this was limited in its usefulness by the need to provide separate boilers (and men to fire them) or steam lines for each individual item of steam-driven equipment about the yard. The development of hydraulic, pneumatic and particularly electrical machinery overcame these problems, as water pipes, air lines or electrical cable could be run to any part of the yard. This equipment was slowly but steadily adopted from about 1880, although shipbuilders still remained reluctant to commit themselves to heavy capital expenditure.

The availability of hydraulic and pneumatic power also allowed gradual mechanisation of riveting, one of the most labour-intensive jobs in the shipyard: a large ocean-going freighter needed almost a million rivets, and two million rivet holes.[92] There was some opposition from the strongly-unionised shipyard workers, who feared their piece-work rates and

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90. Newman, B., *Materials Handling in British Shipbuilding 1850-1945*.
91. Newman, B., *Plate and Section Working Machinery in British Shipbuilding 1850-1945*. (Glasgow, n.d.).
92. Newman, B., *Plate and Section Working Machinery in British Shipbuilding 1850-1945*; Pollard, S. and Robertson, P., pages 122-3.

craft status would be affected by power riveting. However, this was tempered by the realisation that the machinery reduced the severe physical demands of the job and meant career riveters could continue to work beyond middle-age.[93] Welding as a means of joining plates was eventually to replace riveting altogether, but in British yards before 1914 it was not used for hull construction, although it was employed in repair work.

The modest mechanisation of shipbuilding did have its effect on productivity. Figures for productivity changes are calculated and cited by Pollard and Robertson only for the period from the mid 1880s to 1914, and these show a gain of about 50 per cent over these 30 years.[94] The laggardly adoption of mechanisation makes it likely that productivity gains were more modest from 1850 to 1880, if indeed there were any gains.

The evidence base for improvements in efficiency is relatively small, and those calculating them have been mostly concerned with the bigger yards, which in the main were constructing large, ocean-going ships. Were the same efficiencies achieved in the yards constructing colliers and coastal bulk carriers? No information has been found on efficiency changes in the west coast yards building coastal bulk carriers. However, it must be remembered that the yards building coastal vessels were not necessarily small: Charles Palmer, for instance, was not only a major builder of early colliers but was also amongst the largest and most forward-looking of

93. Pollard, S. and Robertson, P., page 122.
94. Pollard, S. and Robertson, P., pages 186 to 194 calculate their own figures, based on data relating to the Denny and Connell yards on the Clyde, and also cite a price index compiled by Feinstein. There are divergences in the figures, but the overall increases are very close to 50% for both series.

shipbuilders, even investing in his own steel works as early as the 1850s.[95] The smaller yards had to compete for orders with the likes of Palmer, which gave them every incentive to stay competitive by matching the admittedly modest productivity gains of the flagship yards.

Changes in the rules for building iron ships

Lloyd's Register of Shipping, the major British classification society, was extremely cautious about the adoption of iron for shipbuilding.[96] The scientific approach to building in iron pioneered by men such as Scott Russell, Brunel, Fairbairn, Rankine and Napier was instrumental in persuading Lloyd's Register to revise its rules, but major change did not come until 1870 when surveyor Bernard Waymouth (later Secretary to Lloyd's Register) was largely responsible for rewriting the rules for iron ships.[97] The new rules recognised that the stresses on a hull at sea required it to be strongest towards the middle,, and therefore to require proportionally thicker iron work (the scantlings) at this point, whilst the extremities were subject to less stress and could be built more lightly. The overall result was to reduce the weight of iron work in a hull by 20 per cent. The corresponding reduction in price was so significant that construction of some ships was actually held back in anticipation of the new rules coming into effect, and the changes in rules undoubtedly helped fuel the boom in iron shipbuilding of the early 1870s.

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95. Pollard, S. and Robertson, P., page 29.
96. Frustration with this caution was a factor in underwriters based in Liverpool publishing their own register annually from 1862, the *Liverpool Underwriters' Registry for Iron Vessels*.
97. Coates, J., and Waymouth, B. 'The change from wood to steel ships' *Transactions of the Newcomen Society*, 1999-2000; **71**: 257-68.