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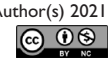

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Navigating the Great Barrier Reef: The Inner and Outer Routes, 1815-1860

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Abstract

This article examines naval surveying voyages undertaken between 1815 and 1860 by Phillip Parker King, Francis Price Blackwood, Owen Stanley and Henry Mangles Denham to discuss the improvements to the navigation of the Inner and Outer shipping routes along the Great Barrier Reef. The Inner Route lay between Australia's east coast and the western edge of the reefs while the Outer Route was situated in open sea beyond the eastern edge of the reefs. These were some of the most dangerous waters for ships in the Pacific off Australia's east coast. The article analyses the improvements to both routes resulting from the surveying of the naval commanders referred to above; it explains why the choice between the Inner and Outer routes was difficult to make; and it shows that the Outer Route was increasingly favoured by merchant vessels.

Keywords

Australia, Great Barrier Reef, navigation, shipping

Finding a safe route through the Great Barrier Reef was a major problem confronting nineteenth-century navigators. Comprising 3,000 individual reefs and 900 islands, the Great Barrier Reef is the largest coral reef ecosystem in the world. Its rocky islets and coral cays, stretching to the east of Australia's mainland for around 1,250 miles from Breaksea Spit (24°30'S, 153°20'E) to Bristow Island, near the coast of New Guinea

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(9°15'S, 143°20'E), include almost all types of reefs, except atolls.[1] The complexity of the available passages and the ever-present danger of shipwreck made navigation through the Reef, especially near Australia's northeast coast and the Coral Sea, one of the most hazardous parts of the Pacific.[2] Before 1815, James Cook, Matthew Flinders and several less well-known navigators had sailed through the Reef with difficulty. Cook's *Endeavour* struck a reef near Cape Tribulation in 1770 and struggled to guide the ship to a mainland beach, while Flinders found it difficult to find even small passages through the Reef.[3]

All ships sailing north from Sydney en route to Indonesia, Singapore and the Indian Ocean via Torres Strait, the Arafura Sea and the Timor Sea encountered the intricacies of the Great Barrier Reef. Strong ocean currents could push ships onto reefs hidden beneath the sea's surface that mariners could not see even in daylight until they almost hit them. The need for safer, more precisely charted shipping routes was sorely needed because of the recorded loss of ships in the region of the Great Barrier Reef, Torres Strait and Coral Sea. Between 1791 and 1850 more than 20 ships were recorded lost in this region.[4] Voyages despatched through the Reef during this period aimed to tame the obstacles to navigation found among the plethora of coral rocks.[5]

Navigators had to make two important decisions when traversing the Great Barrier Reef: whether to sail northwards from Sydney to Cape York via an Inner Route between the east coast and the western edge of the reefs, or to follow an Outer Route in open sea beyond the eastern edge of the reefs. The selection of route was by no means an easy choice, and both the Inner and Outer routes had their advocates. As an authoritative late nineteenth-century navigational directory put it: 'Opinions are divided as to the respective

1. Among many studies on the evolution of the Reef are James Bowen and Margarita Bowen, *The Great Barrier Reef: History, Science, Heritage* (Cambridge, 2002); David Hopley, Scott G. Smithers and Kevin E. Parnell, *The Geomorphology of the Great Barrier Reef: Development, Diversity, and Change* (Cambridge, 2007); and Iain McCalman, *The Reef, A Passionate History: The Great Barrier Reef from Captain Cook to Climate Change* (New York, 2014).
2. Alexander George Findlay, *A Directory for the Navigation of the South Pacific Ocean, with Descriptions of its Coasts, Islands etc. from the Straits of Magalhaens to Panama, and those of New Zealand, Australia etc.; its Winds, Currents, and Passages* (London, 1884), 955.
3. J. C. Beaglehole, *The Life of Captain James Cook* (Stanford, CA, 1974), 236–7, 244–7; McCalman, *The Reef*, 39–63. For comments by Cook and Flinders on the dangers involved, see J. C. Beaglehole, ed., *The Journals of Captain James Cook on his Voyages of Discovery. Volume 1. The Voyage of the Endeavour, 1768–1771* (Cambridge, 1955), 343–4, 361, 370, and Kenneth Morgan, ed., *Australia Circumnavigated: The Journals of Matthew Flinders in the Investigator, 1801–1803*, 2 vols. (London, 2016), II, 120, 124, 130–1, 133; Rohan Lloyd, 'An Extraordinary Barrier: European Exploration, Shipwrecks and Early Heritage Values on the Great Barrier Reef 1770–1860', *History Australia*, 17, No. 1 (2020), 44.
4. Jim Allen and Peter Corris, eds., *The Journal of John Sweatman: A Nineteenth Century Surveying Voyage in North Australia and Torres Strait* (St Lucia, QLD, 1977), xvi. See also Lance Patterson, *Wreck–collections: Ships and Shipwrecks in Queensland Waters* (Caloundra, QLD, 2003).
5. Clem Lack, 'The Taming of the Great Barrier Reef', *Journal of the Royal Historical Society of Queensland*, 6, No. 1 (1959), 130–5.

merits of the two passages; for despatch, the Outer Route is certainly to be preferred: but, under all circumstances, the Inner Route was generally considered the safest.'[6] Over the entire length of the Reef, the Inner Route was 200 miles shorter than the Outer Route, the water was smooth, and shelter was better during the monsoon season. However, unmarked reefs and sandbanks were abundant, regular soundings were required in daylight, navigation for the first 500 miles after reaching Cape York required care and precision to avoid reefs, and it was necessary to anchor at night. Ships following the Outer Route could proceed at all hours without having to anchor but they encountered many uncharted coral outcrops, narrow gaps through a maze of reefs with no obvious passage to open sea, strong, unpredictable ocean currents, and the full force of monsoons at certain times of the year.[7]

For the period 1815–60, when most navigational improvements on tracks through the Great Barrier Reef were made, this article analyses the means by which, in several stages associated with particular commanders and voyages, the intricacies of steering through the mass of coral rock was advanced and clear conclusions determined about the merits of the Inner or Outer Route. Four naval commanders led voyages that concentrated on this navigational problem. First, the naval hydrographer Phillip Parker King surveyed the Great Barrier Reef from a base in Sydney (or Port Jackson) between 1817 and 1822. King made four voyages in the *Mermaid* and one in the *Bathurst* with the specific brief of investigating those parts of Australia's coastline that had not been previously explored or charted.[8] Second, between 1842 and 1845, Captain Francis Price Blackwood led a comprehensive survey of the Reef and Torres Strait in HMS *Fly*, accompanied by the *Bramble*, a cutter commanded by Lieutenant Charles Yule.[9] Third, between 1847 and 1850 Captain Owen Stanley in the *Rattlesnake* made another survey of the Inner Route and the eastern entrance to Torres Strait from the Great Barrier Reef.[10] Fourth, between 1853 and 1860 Captain Henry Mangles Denham in the *Herald* commanded several surveying voyages of the reefs in the Coral Sea.[11]

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6. Findlay, *A Directory*, 949. For discussion of the routes by captains who had sailed through both, see two articles in *The Nautical Magazine and Naval Chronicle* (1837): Thomas Robson, 'Comparative Merits of the Outer and Inner Routes to Torres Strait', letter of 23 July 1836, 67–83, and Samuel Ashmore, 'The Outer Passage to Torres Straits', letter of 31 May 1836, 211–4. Robson advocated following the Inner Route, while Ashmore thought the choice was difficult to decide.
7. G.W. Earle, 'The Steam Route from Singapore to Sydney, via Torres Straits', *The Nautical Magazine and Naval Chronicle* (1853), 178; Stephen Sheaffe, 'Samuel Ashmore and Tracks through the Great Barrier Reef', *Queensland History Journal*, 24, No. 3 (2019), 277. See also Allan McInnes, 'Dangers and Difficulties of the Torres Strait and Inner Route', *Journal of the Royal Historical Society of Queensland*, 10, No. 4 (1979), 47–73.
8. Marsden Hordern, *King of the Australian Coast: The Work of Phillip Parker King in the Mermaid and Bathurst 1817–1822* (Melbourne, 1997).
9. J. Beete Jukes, *Narrative of the Surveying Voyage of H.M.S. Fly, commanded by Captain F. Blackwood, R.N. . ..*, 2 vols. (London, 1847).
10. Jordan Goodman, *The Rattlesnake: A Voyage of Discovery to the Coral Sea* (London, 2005).
11. Andrew David, *The Voyage of H.M.S. Herald to Australia and the South–West Pacific 1852–1861 under the Command of Captain Henry Mangles Denham* (Melbourne, 1995).

Each of these voyages, as the discussion below explains, made a distinctive contribution to the exploration of the Great Barrier Reef, leading to considerable navigational improvements along Australia's east coast between 1815 and 1860. These surveying voyages have been explored by historians in terms of individual expeditions but not, as in this article, in relation to their collective contribution to improved navigation through the Great Barrier Reef. Harnessing an account of these voyages together will indicate the ways in which navigation through the Reef improved through incremental additions to knowledge based on expert surveying, and will also explain the logical stages by which detailed understanding of the position of reefs and their danger to shipping was gathered. Improving navigation through the Great Barrier Reef was a daunting task but necessary for the increasing flows of shipping along its routes in the nineteenth century.[12]

Phillip Parker King and the *Mermaid*

Phillip Parker King's voyages between 1817 and 1822 were the first large-scale expeditions of Australia's coasts from Sydney made by an Australian-born commander, but they came under the auspices of the British Admiralty. The Admiralty Hydrographer, Thomas Hurd, wanted to see the completion of the Australian maritime surveying work of Matthew Flinders, who had died in 1814.[13] After setting up what later became the Royal Navy Surveying Service in 1817, Hurd received approval for a thorough hydrographic survey of north and northwest Australia, a large area which, except for the Gulf of Carpentaria, had not yet been explored thoroughly. King, who was appointed commander of the expedition, received two separate sets of instructions from the Admiralty and the Colonial Office, but they made no specific mention of exploring the Great Barrier Reef.[14] However, though the expedition concentrated on north and northwest Australia, King personally determined that improving the route for shipping through the Reef should play a significant role in his cruises. He wanted to improve routes through the navigational obstacles of 'numerous reefs, many as yet unknown'.[15]

King's first opportunity to sail through the Reef occurred on the *Mermaid*'s second voyage, in 1819. King noted that a passage via Torres Strait would shorten the voyage and enable him to spend enough time on his survey of the northwestern coast.[16] Sailing through the Great Barrier Reef, he steered a course closer to the mainland than either Cook or Flinders. King was interested in establishing the best route for shipping through this labyrinth of coral rock. An Outer Route beyond the Reef was more susceptible to storms than

12. This article is not concerned with the geological, botanical and ethnographical aspects of these voyages.
13. For a recent detailed appraisal of Flinders' Australian surveying, see Kenneth Morgan, *Matthew Flinders, Maritime Explorer of Australia* (London, 2016).
14. The instructions are printed in Phillip Parker King, *Narrative of a Survey of the Intertropical and Western Coasts of Australia Performed between the Years 1818 and 1822 by Captain Phillip King*, 2 vols. (London, 1827; repr. Adelaide, 2012), I, xxvii, xxxii–xxxiii.
15. King, *Narrative of a Survey*, I, 386.
16. Mitchell Library, State Library of New South Wales, Sydney (hereafter ML), King to Thomas Hurd, 23 February 1819, Phillip Parker King letterbook (1817–22), MLMSS 4429.

an Inner Route, where the waters were generally calmer and anchorages were available. Many more shipwrecks happened on the Outer Route than on the Inner Route. King therefore decided that he should prepare a proper chart of the Inner Route for the advantage of future voyages. He carried out this task by hugging the shoreline on the inside of the reefs.[17] King's instructions did not specify that he should land on the east coast because Cook and Flinders had already explored it. The only landings made on the east coast were therefore confined to investigations seeking rivers or openings between the latitude of 22° and Torres Strait, a distance of more than 700 miles.[18] The *Mermaid* passed through Torres Strait to the Gulf of Carpentaria, but nothing of significance was noted.[19]

The third voyage of the *Mermaid* began on 14 June 1820, but the ship ran into a violent storm that broke her bowsprit and set adrift one of her boats. King was forced to return to Port Jackson.[20] King left Port Jackson again on 14 July, heading north, but navigation proved difficult off the Queensland coast and the ship was grounded off Port Bowen after coming across new shoals washed up by the sea. After setting out again, the ship sprang a leak and had to stop at Endeavour River for repairs.[21] During this part of the voyage, King did not delay by landing anywhere but concentrated on adding to the chart made on his last voyage, which he improved and extended considerably.[22]

The *Mermaid* took the Inner Route through the Great Barrier Reef that King had followed on the ship's last voyage. Where possible, King sailed closer to the mainland than he had done before.[23] From Port Jackson to Torres Strait, John Septimus Roe, an assistant to King, wrote, 'we had the satisfaction of fixing the positions of 40 or 50 reefs or shoals that had no previous existence in any former charts'.[24] King hoped his survey on this voyage would identify geographical features of the coast left in 'a questionable state' on his last voyage.[25] The *Mermaid* passed through Torres Strait via Endeavour Strait. King praised the navigational track Flinders had followed between the Prince of Wales islands and Northwest reef.[26]

17. Robert Tiley, *The Mermaid Tree: How a Tiny Unknown Ship Opened Australia's North and West to Development, Dreams and Disappointment* (Sydney, 2006), 50–1.
18. Phillip Parker King, 'On the Maritime Geography of Australia', in Barron Field, ed., *Geographical Memoirs, or New South Wales; by Various Hands. . .together with Other Papers on the Aborigines, the Geology, the Botany, the Timber, the Astronomy, and the Metereology of New South Wales and Van Diemen's Land* (London, 1825), 277.
19. King, *Narrative of a Survey*, I, 251, 272.
20. ML, King to the Admiralty, 26 May 1820, Phillip Parker King letterbook (1817–22), MLMSS 4429.
21. Allan Cunningham to William Townsend Aiton, 1 February 1821, in A. E. Orchard and T. A. Orchard, eds., *Allan Cunningham: Letters of a Botanist/Explorer 1791–1839* (Weston Creek, ACT, 2015), 130.
22. The National Archives, Kew (hereafter TNA), ADM 1/2980, King to the Admiralty, 1 February 1821.
23. Tiley, *The Mermaid Tree*, 75; Hordern, *King of the Australian Coast*, 235; ML, Roe to his father, 29 January 1821, item 157, John Septimus Roe letters, series 04, MLMSS 7964/4. King summarised the best passages to follow through the coral reefs off the Queensland coast in his *Narrative of a Survey*, I, 386–7.
24. ML, Roe to his father, 29 January 1821, item 157, John Septimus Roe letters, series 04, MLMSS 7964/4.
25. ML, King to Goulburn, 26 May 1820, Phillip Parker King letterbook (1817–22), MLMSS 4429.
26. TNA, ADM 1/2980, King to the Admiralty, 1 February 1821.

King later became a staunch advocate of the Inner Route, produced sailing directions for this course, and later wrote a pamphlet on this topic. While acknowledging the necessity for anchoring each night when traversing the Inner Route, King provided a systematic step-by-step account of his preferred route through the Reef, taking account of tides, the direction to follow, the depths of the water, and how to avoid reefs, shoals and islets. Among his recommendations were to avoid the route within the Cumberland Isles through Whitsunday Passage because of unsteady breezes that commonly caused delays there and explaining where the passage's reefs became narrower, and therefore more dangerous, near Cape Grafton.[27] He thought he had completed the examination of Australia's coasts for the general purposes of navigation, though he drew attention to many blank spaces on charts that would be interesting for others to examine.[28]

King's account of his surveying in Australian waters was written up and published as a *Narrative of a Survey of the Intertropical and Western Coasts of Australia Performed between the Years 1818 and 1822* (1827). This had a long appendix detailing shoals and reefs and 'Directions for a passage within the reefs and through Torres Strait'.[29] King concluded that close attention to his charts of the coastal waters from Breaksea Spit to Cape York would neutralise the dangers of bad weather and abundant reefs on the Inner Route.[30] In a newspaper article in 1834, King recommended the Inner Route as being 'advantageous to navigation', adding that 'it releases the commander from a considerable degree of anxiety and may eventually prove the means of extending our colonial possessions within the tropical regions of this continent'.[31]

Francis Blackwood and the *Fly*

In 1829, the Irish naval officer Francis Beaufort was appointed Admiralty hydrographer. While in post over the next quarter century, he oversaw many voyages of maritime exploration, and had a particular interest in seeing the completion of the work of Flinders and Phillip Parker King in surveying blank spaces on charts of Australia's coasts.[32] After the *Beagle*'s surveys in Australian waters (1837–43), which did not focus particularly on the east coast, Beaufort was determined that the next surveying expedition would grapple with the need to chart safe routes through the Great Barrier Reef.[33] Francis P. Blackwood, who in 1833 had surveyed part of the northeastern Australian coast in H.M.S. *Hyacinth*, was appointed commander of the *Fly*, with instructions to carry out this task.[34] He was

27. Phillip Parker King, *Directions for the Inner Route from Sydney to Torres Strait* (London, 1847), 6, 8.
28. King, *Narrative of a Survey*, II, 243.
29. Bowen and Bowen, *The Great Barrier Reef*, 81.
30. King, *Narrative of a Survey*, II, 258–9.
31. Phillip Parker King, *Sydney Herald*, 20 January 1834, 1.
32. Marsden Hordern, *Mariners are Warned! John Lort Stokes and H.M.S. Beagle in Australia, 1837–1843* (Melbourne, 1989), 9.
33. The *Beagle* passed through the Reef on its third voyage in 1839. Its commander, John Lort Stokes, agreed with Phillip Parker King that the Inner Route was the preferred passage through the coral rocks: see Lloyd, 'An Extraordinary Barrier', 49.
34. Ann Mozley, 'Blackwood, Francis Price (1809–1854)' in Douglas Pike, ed., *Australian Dictionary of Biography* (Melbourne, 1966), I, 50.

accompanied by the cutter *Bramble*, under Lieutenant Charles Yule.[35] Beaufort wanted the survey completed successfully, and urged Blackwood to take time and care to negotiate his passages through coral reef. The intention was to find a good opening in the Reef for merchant vessels.[36]

The *Mermaid*'s examination of the Inner Route through the Great Barrier Reef 20 years earlier had not had time to examine and chart all of the manifold hazards to vessels sailing along that route: this was the demanding challenge faced by the *Fly*. There was a need to settle the respective merits of the Inner and Outer routes, and to find out how ships could transfer from one to the other, should they wish to sail continuously rather than anchoring at night.[37] Blackwood was expected to survey nearly 500 miles (about half) of the outer reef, including the Capricorn Islands, Whitsunday Passage and Swain Reefs. As for Torres Strait, an examination of the western entrance needed to be made as only one ship had ever sailed from west to east through the strait.[38]

The instructions for the *Fly* and the *Bramble* enjoined them to proceed to Sydney, where they would refresh their provisions and water and acquire all available information about the Great Barrier Reef and its openings. Blackwood was to survey the eastern edge of the entire chain of reefs; to make detailed plans for all safe routes through them; to devise a practical way of marking them with beacons; to determine the position and dimensions of several detached reefs stretching towards Lord Howe Island; to examine and chart reefs to the westward of New Caledonia to define the eastern and western limits of that channel; to collate the evidence amassed by Bligh, Flinders, King and other navigators about a safe entrance to Torres Strait; to improve upon their findings; and to carry out a full survey of Endeavour Strait – one main route through Torres Strait – with details on its soundings, tides and channels.[39] Blackwood's orders instructed him to conduct his surveys carefully; they counselled against him undertaking running surveys 'in which much work is apparently executed but no accurate knowledge obtained useful either to mariner or geographer'.[40]

Blackwood thought it wiser to work gradually along the whole length of the Reef, in order to leave no part unexamined, than to undertake the survey in patches. He realised this would be a tedious *modus operandi* but considered it was the only method that would yield satisfactory results.[41] The *Fly*'s survey cruise in 1843 was mainly devoted to locating a safe route through the Great Barrier Reef to Torres Strait. This was a difficult undertaking, for many rocks, reefs and shoals needed to be avoided. Blackwood surveyed the Reef from Sandy Cape, on Fraser Island, northwards. He began his examination outside of the reefs, but because the *Fly* had lost wood on its starboard side and lay

35. Tiley, *The Mermaid Tree*, 234.
36. Goodman, *The Rattlesnake*, 12.
37. Jukes, *Narrative of the Surveying Voyage*, I, 311.
38. Tiley, *The Mermaid Tree*, 232–3. For a description of the reefs from Sandy Cape to Torres Strait, see Jukes, *Narrative of the Surveying Voyage*, I, 318–32.
39. Jukes, *Narrative of the Surveying Voyage*, I, 256–8.
40. United Kingdom Hydrographic Office, Ministry of Defence Archives, Taunton (hereafter UKHO), Proposed orders for Capt. Blackwood, 29 March 1842, Minute book no. 3 (1837–42).
41. UKHO, Blackwood to Beaufort, 29 April 1843, Letterbook no. 11 (1842–4).

under heavy strain while at anchor, he steered in through the reefs to Port Bowen where it took three weeks to repair the vessel.[42]

Resuming the survey of the Great Barrier Reef, Blackwood examined the Capricorn group of islands over six days in January 1843. By late March the *Fly* had anchored at the northwest end of the Whitsunday Passage, which Blackwood took particular care to survey as Cook and Flinders had both passed it by.[43] A fortnight in late May and early June involved surveying Rockingham Bay. Blackwood then examined the outer edge of the Great Barrier Reef between Lizard Island and Cape Melville.[44] On 1 August 1843, the *Fly* anchored in the Pandora entrance where HMS *Pandora* was lost in 1791 on her return from Tahiti. From this location Blackwood had to decide the best way of approaching Torres Strait safely. He opted for a passage from Raine Island, situated about 375 miles northwest of the modern city of Cairns. He wanted a beacon built there as a marker easily spotted by ships, and this structure was erected in 1844 with the use of convict labour. It was visible for 13 nautical miles. This was the first offshore infrastructure built to aid vessels sailing in the vicinity.[45] The low-lying Raine Island, surrounded by coral reef, lay at the entrance to one of the widest and clearest openings through the Great Barrier Reef. From Raine Island, located on the Outer Route, ships could proceed to the Inner Route and Torres Strait.[46] Blackwood thought a ship proceeding cautiously could pass through this passage in 48 hours provided it took the precaution of anchoring during the night.[47]

The *Fly*'s subsequent cruises continued survey work covering the Great Barrier Reef, Torres Strait and Australia's north coast.[48] Examination of the southern section of the Great Barrier Reef found a clear and safe channel could be followed, about 45 miles wide, that was suitable for ships proceeding towards the mainland. Hydrographical surveying indicated that a sea clear of coral reefs existed between the southern extreme of the Reef and Flinders' Wreck Reef, located in the southern part of the Coral Sea Islands. However, the outer anchorages located in the vicinity were not recommended 'as a very strong undercurrent and foul rocky ground make them highly dangerous'.[49] More generally, the

42. UKHO, SL 29, Blackwood to Beaufort, 20 April 1843, Captain's letters: Blackwood 1841–6. For a detailed description of the dangers of navigating the Great Barrier Reef on the *Fly*'s voyage, see UKHO, OD 79, HMS *Fly* (1842–4), vol. 3: Australia East Coast and Great Barrier Reef.
43. UKHO, SL 29, Blackwood to Beaufort, 29 April 1843, Captain's letters: Blackwood 1841–6.
44. McInnes, 'Dangers and Difficulties', 58–60.
45. Jukes, *Narrative of the Surveying Voyage*, I, 9–10, 46, 90, 99, 131; Tiley, *The Mermaid Tree*, 234, 236; *Letters and Extracts from the Addresses and Occasional Writings of J. Beete Jukes* (London, 1871), 191. Unfortunately, the beacon became a wreck trap for navigators: see Robert Lawrence Fraser, 'Comparative Routes through Torres Strait', *The Nautical Magazine* (1853), 214, and Martin Gibbs and Ewen McPhee, 'The Raine Island Entrance: Wreck Traps and the Search for a Safe Way through the Great Barrier Reef', *The Great Circle*, 26, No. 2 (2004), 24–54.
46. *Letters and Extracts*, 226.
47. UKHO, SL 29, Blackwood to Beaufort, 26 Oct. 1844, Captain's letters: Blackwood 1841–6. For detailed consideration of the navigation through Torres Strait, see UKHO, OD 90, Frederick J. Evans, Master's remarks, HMS surveying ship *Fly*, 1845–6.
48. Jukes, *Narrative of the Surveying Voyage*, I, 136, 349–57.
49. UKHO, OD 77, *H.M.S. Fly* Remark Book, vol. 1 (1842–6), fol. 93.

officers on the *Fly* found many channels through the Great Barrier Reef were not more than a quarter of a mile in width and a little more than that in length, with a rapid tide either in or out, making it 'an affair of some anxiety steering a ship through them'. Care was needed when sailing near the Reef when the sun was gleaming in summertime because the glare made it difficult to make out various sunken patches.[50]

On the *Fly*'s third cruise the north-east entrance into Torres Strait was surveyed. This discovered a new track called the Great North East Channel that was to become the main channel in the future for ships sailing from the northern end of the Reef to Endeavour Strait. The Great North East Channel passed between Bampton Island, near New Guinea, and Darnley Island, on the Reef. Blackwood surveyed this area trigonometrically and charted it on a scale of half an inch to a mile. This 16-mile wide passage was clear of sunken dangers, and averaged between nine and 12 fathoms in depth. Good anchorages were available all along the passage. It would be possible to follow this course through Torres Strait during the monsoon season. Blackwood was convinced that his charts would confirm this view.[51] Blackwood considered this route from Cape York to Portlock's Reef – a far northern part of the Barrier Reef – the safest channel through Torres Strait.[52] It soon superseded the passage from Raine Island to Torres Strait, which mariners found difficult to locate and navigate despite the erection of the beacon, especially in difficult weather.[53]

The *Fly* and the *Bramble* negotiated many islets, detached reefs and shoals in shallow waters between the Great Barrier Reef and the eastern entrance to Torres Strait, one of the world's most challenging navigational routes for mariners.[54] Blackwood compiled charts of the Reef as well as a printed pamphlet summarising his views on the Outer Route to Torres Strait. This advanced maritime knowledge of the possible routes through the reef, but it did not complete that work because Blackwood had not surveyed the seas north of Rockingham Bay, situated in far north Queensland and opening onto the Coral Sea.[55] He knew that the remaining part of the Great Barrier Reef between 17° and 21°S still needed surveying, and recommended that this would be best carried out by a steam vessel 'in this intricate & coral studded sea'.[56]

Blackwood's pamphlet weighed up the merits and demerits of the two main routes through the Great Barrier Reef towards Torres Strait. Recognising that opinions were

50. UKHO, OD 78, *H.M.S. Fly*: Australia East Coast Great Barrier Reef, vol. 2 (1843), fols. 13–14 (quotation on fol. 13).
51. UKHO, SL 29, Blackwood to Beaufort, 17 April, 8 June and 19 July 1845, Captain's letters: Blackwood 1841–6.
52. UKHO, OD 78, Blackwood to Lt. Yule, 18 Oct. 1845, *H.M.S. Fly*: Australia East Coast Great Barrier Reef, vol. 2 (1843), fol. 50.
53. UKHO, SL 29, Blackwood to Beaufort, 23 July 1845, Captain's letters: Blackwood 1841–6; Tiley, *The Mermaid Tree*, 239; Findlay, *A Directory for the Navigation of the South Pacific Ocean*, 945.
54. J. H. S. Osborn, 'Torres Strait and the Inner Route', *The Journal of Navigation*, 30, No. 1 (1977), 21.
55. F. Blackwood, *Directions for the Outer Passage from Sydney to Torres Strait to Accompany the Chart of the Barrier Reefs* (London, 1847); Goodman, *The Rattlesnake*, 14.
56. UKHO, SL 29, Blackwood to Beaufort, 1 Sept. 1846, Captain's Letters: Blackwood 1841–6.

divided on which was the preferred passage, Blackwood noted that the Inner Route was the safest, navigating between Australia's east coast and the reefs while the Outer Route, which involved sailing between the eastern edge of the reefs and New Caledonia, offered a faster passage. Blackwood advised navigators taking the Inner Route to follow Phillip Parker King's instructions on this passage precisely in order to avoid numerous shoals. For the Outer Route, he warned mariners about the impact of the trade winds on ebb tides in the northern reaches of the reef.[57]

John Beete Jukes, the geologist in the *Fly*, published his views about the routes through Torres Strait. Realising that the whole commerce of eastern Australia and the Pacific Islands was compelled to use the strait en route from the Coral Sea to the Indian Ocean, he noted that the Inner Route identified by King was intricate, narrow but safe, with good anchorages all along its course, while the voyage in the *Fly* was the first serious survey of the Outer Route. Along that route Jukes had discovered there was a passage between 60 and 100 miles in width where there were no continuous reefs but many detached reefs, some known but many unknown, and no anchorages. Jukes set down his observations on the composition of coral reefs. He also divided them into three types: linear reefs, forming the outer edge or barrier; detached reefs, lying outside the barrier; and inner reefs, lying between the barrier and the shore.[58]

Jukes became familiar on a daily basis with the intricacies of the Great Barrier Reef. He summed up its navigational difficulties succinctly: inside the reef was 'smooth water about 20 fathoms deep, full of coral patches and sand-banks, outside of them the sea is unfathomable, and the whole swell of the South Pacific Ocean, urged by the continual force of the trade-winds, bursts on their outer edge'.[59] After the voyage ended, Jukes produced the first published record of the Great Barrier Reef. This included detailed evidence from observations made as the *Fly* moved from reef to reef. Its conclusions supported Charles Darwin's hypothesis about the formation of coral reefs, presented in a published paper in 1842.[60]

Jukes's narrative of the *Fly*'s cruises candidly pointed out the problems of sailing through Torres Strait despite the advances in knowledge of channels to be followed that its surveying had established. 'However complete and accurate may be the surveys of Torres Strait and the Coral Sea,' he argued, 'it must always remain a dangerous navigation. Slight accidents, such as hazy weather, mistakes in the reckoning, unknown errors in the chronometer or sextant, or want of completeness or soundness in the rigging or finding of the vessel (to say nothing of carelessness or incapacity in the navigator), will always cause a pretty high average of wrecks in the vessels passing through Torres Strait.'[61] Jukes agreed with Blackwood that the Inner Route offered the safest passages through the Great Barrier Reef.[62]

By 1845, Blackwood and his associates had tired of their work among the labyrinthine maze of the reefs. 'My zeal after three such years as I have had is evaporated,' he

57. Blackwood, *Directions for the Outer Passage*, 1, 6.
58. Jukes, *Narrative of the Surveying Voyage*, I, 312–7.
59. *Letters and Extracts*, 194.
60. Ann Moyal, '*A Bright & Savage Land': Scientists in Colonial Australia* (Sydney, 1986), 76.
61. Jukes, *Narrative of the Surveying Voyage*, I, 304.
62. Lloyd, 'An Extraordinary Barrier', 50.

wrote to Beaufort, adding 'all on board have had enough of the Coral Reef'.[63] Nevertheless, Blackwood hoped his remark books in combination with his charts would be 'of real practical utility to Mariners who take the outer route through Torres Strait'.[64] Beaufort recalled Blackwood and then set about immediately to organise another expedition to complete the surveying of the Great Barrier Reef. After Blackwood returned to England in 1846, this work was continued in the *Bramble* under Charles Yule, but Beaufort intended to advance this work with a completely new voyage commanded by an experienced hydrographer.[65]

Owen Stanley and the *Rattlesnake*

After Blackwood's return to England, Beaufort immediately organised a follow-up voyage to complete work on navigating the Great Barrier Reef. The commander was Captain Owen Stanley, who had surveyed Australia's north coast between 1837 and 1843 in HMS *Britomart*.[66] Stanley received two sets of instructions for the *Rattlesnake*'s voyage – one from the Admiralty and the other from its Hydrographic Office. The former emphasised the requirement to carry out further examination of the eastern entrance to Torres Strait from the Great Barrier Reef. The *Fly* had surveyed Raine Island Passage, but treacherous waters in that vicinity needed additional investigation and it was desirable to locate a further, more northerly entrance to the strait. The Admiralty wanted the *Rattlesnake* to search for an opening to help ships taking the Outer Route around the Great Barrier Reef. Though these vessels benefited from sailing in deep water, the openings in the Reef were narrow and needed further examination. Stanley was based at Sydney for refreshment and refitment, with the *Bramble, Asp* and *Castlereagh* as tenders for use in more shallow waters than were suitable for the *Fly*.[67]

The hydrographic instructions, drawn up by Beaufort, were more detailed. They differed from the Admiralty directives by emphasising the need for further surveying of the Inner Route through the Great Barrier Reef.[68] Beaufort acknowledged the need for further knowledge of safe passages via the Outer Route but also wanted the safety of the inshore passage improved.[69] Stanley was enjoined to use the detailed charts of Parker King to improve soundings in all coastal areas visited. This was intended partly to facilitate continuous sailing at night.[70] Stanley was to survey the Inner Route between Hervey Bay and the Great Barrier Reef with a view to this passage becoming more frequently used when regular shipping lanes were established between Sydney and Singapore – a

63. UKHO Minute Book no. 6 (1846–9).
64. UKHO, Blackwood to Beaufort, 24 July 1846, Incoming Letters prior to 1857. Blackwood's Remark books are deposited at UKHO, OD 77–9.
65. Goodman, *The Rattlesnake*, 14.
66. Goodman, *The Rattlesnake*, 16–9.
67. Goodman, *The Rattlesnake*, 135; John MacGillivray, *Narrative of the Voyage of HMS Rattlesnake*, 2 vols. (London, 1852), I, 2–3; T. H. Huxley, 'Science at Sea', *Westminster Review*, 61 (January 1854), 101.
68. Goodman, *The Rattlesnake*, 135.
69. MacGillivray, *Narrative of the Voyage*, I, 7.
70. Lloyd, 'An Extraordinary Barrier', 51.

prime focus of the meetings held in Sydney in 1846 by the Select Committee on Steam Navigation with England. King had laid down a feasible passage near the coast but the whole space occupied by the Inner Route needed to be 'carefully examined and triangulated' to avoid the need for frequent anchoring. The *Rattlesnake* was given the more extensive task of improving the hydrography of parts of the Coral Sea that ships might traverse on their way to Torres Strait. This great expanse of sea stretched from Lord Howe Island to New Caledonia and the Louisiade Archipelago. The surveying was to continue in Torres Strait and along New Guinea's southeastern shores, with particular attention given to Bligh's Farewell at the western end of the strait.[71]

In 1847, the *Rattlesnake* examined the Inner Route through the Great Barrier Reef between Rockingham Bay and Jarvis Island, situated near the modern city of Townsville. This coastline was meticulously recorded on 11 sheets. In December 1847 and January 1848, while sailing off the Queensland coast, the *Rattlesnake* found it difficult to find fresh water during a period of drought. After a protracted search for water, Stanley decided that he should take the ship back to Sydney, which was reached on 14 January 1848.[72] On 29 April, the *Rattlesnake* and the *Bramble* left Sydney on a 10-month cruise in order to complete the survey of the Inner Passage through the Great Barrier Reef.[73] This was now deemed a necessity owing to the rapid growth of steam navigation. The smooth waters of the Inner Route were considered better suited to steamships than the unbroken surge of the Pacific Ocean on the Outer Route. Surveying the Inner Route required careful triangulation and soundings laid down for a safe course to be charted.[74]

The survey off the Queensland coast began on 26 May. At various stations, comprising islands, observations for determining astronomical positions were made and recorded. This was tedious and time-consuming work. Soundings were taken from the edge of the reef to the coast. Astronomical readings were noted down. Angles were measured from fixed points, usually on islands.[75] The *Rattlesnake* reached Cape York on 7 October. Meanwhile the *Bramble, Asp* and a second cutter were engaged in a survey of Endeavour Strait and the Prince of Wales Channel, which they finished, thereby competing the survey of the Inner Route between Dunk and Booby islands. The ships arrived back at Sydney on 24 January 1849 after nine months' absence.[76] Stanley informed Beaufort at the Hydrographic Office that a settlement at Cape York would be helpful as a harbour of refuge for vessels approaching Torres Strait in difficult weather – an idea that was never followed up.[77]

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71. Goodman, *The Rattlesnake*, 136; MacGillivray, *Narrative of the Voyage*, I, 6–9; Huxley, 'Science at Sea', 102 (quotation).
72. MacGillivray, *Narrative of the Voyage*, I, 66; Goodman, *The Rattlesnake*, 106–7, 112, 145–7. For a contemporary description of the daily activities on this voyage off the Queensland coast, see Leicestershire and Rutland Record Office, Arthur Packe, Private Journal on H. M.'s surveying vessels the *Rattlesnake* and *Bramble*, DE 1672/15.
73. MacGillivray, *Narrative of the Voyage*, I, 68, 76.
74. Adelaide Lubbock, *Owen Stanley R.N. 1811–1850 Captain of the 'Rattlesnake'* (Melbourne, 1968), 196–7; Adelaide Lubbock, 'Owen Stanley in the Pacific', *The Journal of Pacific History*, 3 (1968), 47–63.
75. Goodman, *The Rattlesnake*, 149–50, 172.
76. MacGillivray, *Narrative of the Voyage*, I, 122, 161.
77. UKHO, SL 15c, Stanley to Beaufort, 31 January 1849, Captain's letters: Owen Stanley & Yule 1846–7.

In 1849, the *Rattlesnake* continued the work of the *Beagle, Fly* and *Bramble* in Torres Strait by charting eight channels, five of which were previously unknown.[78] One of Stanley's charts of Torres Strait contained more than 40,000 depth soundings. The work needed to record these readings was so demanding that Stanley hardly ever left the chart room. The *Rattlesnake* and the *Bramble* then undertook a running survey of the southern coast of New Guinea to the Louisiades, thereby completing the survey. Stanley discovered that the Louisiade archipelago comprised a string of islands encircled by reefs that stretched for 25 miles to the east of New Guinea. Beaufort was keen that these waters should be surveyed in detail because they provided an important passage via Torres Strait between the Pacific and Indian oceans.[79]

Stanley found himself under considerable stress while undertaking his duties in the *Rattlesnake* in difficult surveying conditions. His health deteriorated, and he became gaunt and haggard. Soon after leaving the Louisiade Archipelago he had a paralytic seizure. On arrival at Sydney he was clearly ill.[80] He was found dead in his cabin on 13 March 1850 while the ship lay at anchor in Sydney harbour. He was 38 years old. Some writers later suggested that he had committed suicide, but there is no supporting evidence for this conjecture. It seems, on the contrary, that he had fallen on his head. Stanley's death led to the abandonment of the *Rattlesnake*'s expedition. Yule took command of the vessel, and sailed in her, back to England. No immediate positive results for shipping arose from the *Rattlesnake*'s surveys. A much-anticipated steamship mail contract through Torres Strait never came to fruition; a Torres Strait outpost was not established until 1864; and little attention was given by Britain to navigation in the vicinity of New Guinea.[81]

Nevertheless, the *Rattlesnake*'s detailed surveys had made the Inner Route much safer for ships sailing up Australia's east coast from Sydney and the charts produced were essential for further surveys in Australian waters over the next century. Jordan Goodman has succinctly summed up the achievements of the *Rattlesnake*'s voyage:

> With accurate charts, the inner passage of the Great Barrier Reef could now be used more safely than ever before . . . and this route could attract steam shipping, the technology of the future.

78. Detailed contemporary accounts dealing with these vessels sailing through the reefs to Torres Strait include Cheshire Record Office, Owen Stanley private journal (1849), Correspondence and manuscripts of Owen Stanley, 1837–50; National Library of Australia, Canberra (hereafter NLA), George Inskip, Private journal on board *H.M.S. Bramble* (1849–50), MS 3784, and James Thomas Stanton, Logbook of *H.M.S. Rattlesnake* (1849–50); and John Oxley Library, State Library of Queensland, Charles James Card Diaries (1847–50).
79. Goodman, *The Rattlesnake*, 207, 221, 223; Geoffrey C. Ingleton, *Charting a Continent: A Brief Memoir on the History of Marine Exploration and Hydrographical Surveying in Australian Waters, from the Discoveries of Captain James Cook to the War Activities of the Royal Australian Navy* (Sydney, 1944), 68; Tiley, *The Mermaid Tree*, 250–7, 266.
80. Cheshire Record Office, John Thomson to Mary Thomson, February 1850, Correspondence and manuscripts of Owen Stanley, 1837–50; Goodman, *The Rattlesnake*, 270; Lubbock, *Owen Stanley*, 266.
81. Tiley, *The Mermaid Tree*, 267–8.

> The Indian Ocean, the Coral Sea and the rest of the Pacific Ocean were now connected; trade and imperial ambitions could flow freely from the one ocean to the other.[82]

Thomas Henry Huxley also commented in 1854 on the significance of the *Rattlesnake*'s voyage. In his opinion, it concluded the investigation of:

> the last remaining portion of the globe into which European cruisers and European manufacturers had not penetrated. The great series of ocean explorations for the discovery of new and untrodden lands, within the habitable globe, was thus finished and completed by the voyage of the *Rattlesnake*. Henceforward, those who covet the laurels of discoverers must betake themselves within the limits of Arctic or Antarctic circles.[83]

Henry Mangles Denham and the *Herald*

The final expedition designed to complete the surveying of the Great Barrier Reef was made by Captain Henry Mangles Denham, an experienced hydrographer, in HMS *Herald* in several cruises between 1854 and 1860. Denham's instructions from the Admiralty urged him to explore the navigation and clusters of islands and reefs between Australia's east coast and the eastern end of New Caledonia. The aim was to chart these waters to help mariners involved in the 'increasing traffic between our Australian colonies & the western coast of America'. The voyage was expected to be more extensive than most naval surveys because the Admiralty also wanted to obtain a general knowledge of the physical character and mineral and vegetable production of the places visited.[84]

With a base in Sydney, between 1854 and 1860 the *Herald* undertook surveys in Norfolk Island, Bass Strait, Shark Bay, Sydney Harbour, King George Sound and the Great Barrier Reef as well as making three cruises in the Coral Sea and three visits to Fiji.[85] In 1857, the surveying initially concentrated on the Outer Route from Sydney to Torres Strait via the Coral Sea. Denham intended to follow his instructions to search for all possible dangers on this route and to pinpoint the positions of all the reefs bordering the tracks of vessels using this passage.[86] In 1858–9, Denham undertook two cruises in the Coral Sea, beginning about midway between Australia and New Caledonia. The first cruise lasted from June to December 1858; the second covered the period between April and October 1859. Specific locations covered were Bellona Shoals, South Bellona Reefs, the Chesterfield Archipelago – stretching for almost 200 miles – as well as Bird Islet and its surrounding reef, Cato Island and its nearby reefs. The second cruise followed the Outer Route from Sydney to Torres Strait, and included examinations of Long Island and its area, Kern Reef and the Percy Isles. The survey of the outer edge of the Great Barrier Reef was carried out slowly because the sun needed to be in a suitable position for sighting shoal patches. These voyages took chronometer and tidal readings as well as

82. Goodman, *The Rattlesnake*, 276–7.
83. Huxley, 'Science at Sea', 115.
84. Ray Desmond, *Kew: The History of the Royal Botanic Gardens* (London, 1995), 208.
85. David, *The Voyage of H.M.S. Herald*, 165–9.
86. David, *The Voyage of H.M.S. Herald*, 265, 268, 271–4. Denham's journals on the exploring cruise are available at UKHO, OD 88, 90, 94.

soundings. Metereological information was also gathered. All perceived dangers to mariners were noted. Most of the survey dealt with uncharted areas.[87]

Denham's third cruise of the Coral Sea began in January 1860. This was planned to last four months so that the crew would not be disheartened at the possibility of a longer stay in the tropical heat.[88] Its focus lay in the examination of the reefs adjacent to the Outer Route. The voyage covered 300 miles of the outer edge of the Reef. After charting these treacherous waters, Denham concluded that a ship could reach Singapore from Sydney in 24 days by following the Outer Route rather than the 32 days it took following a route to the south and west of Australia.[89] Mail steamers would find the Inner Route preferable, however, as a ship's position could be fixed from coastal features or nearby islands. With the coming of mail steamers using Torres Strait in 1866, the Inner Route became the preferred passage through the intricacies associated with the Great Barrier Reef. As Andrew David has noted, 'it was uneconomical to erect navigational marks on more than one route'.[90] In 1864, George Henry Richards, the Admiralty hydrographer, claimed that the Inner Route was 'as easy to navigate as the English Channel'.[91]

Denham's surveys in HMS *Herald* produced 200 sheets of charts, plans and drawings.[92] The hydrographical findings were transmitted annually back to the Admiralty. In 1862, the full extent of the surveying carried out on these voyages was laid before the Royal Geographical Society in London. The statistics were impressive. The *Herald* had made 163 determinations of latitude and longitude, 2,601 magnetic results, identifications of 41 islands and 42 reefs and shoals, and surveys of 450 miles of Australian coastline.[93] The Admiralty produced engraved charts with hydrographical details, including bathymetric soundings, arising from the voyages considered in this paper for navigators to find their way safely through the hazardous passages along the Great Barrier Reef and the entrance to Torres Strait.[94]

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87. David, *The Voyage of H.M.S. Herald*, 313, 315, 317, 325, 329, 404.
88. UKHO, OD 88, Captain Denham's journal of the exploring cruise of *H.M.S. Herald*, 1860: Australia East Coast and Coral Sea.
89. David, *The Voyage of H.M.S. Herald*, 342, 348, 354, 363, 376, 381, 397, 405; 'Outer Route from Sydney to Torres Strait', *The Nautical Magazine*, XXIX, No. 4 (1860), 170–3.
90. David, *The Voyage of H.M.S. Herald*, 408.
91. Quoted in Bowen and Bowen, *The Great Barrier Reef*, 106.
92. Michael Pearson, *Great Southern Land: The Maritime Exploration of Terra Australis* (Canberra, 2005), 112.
93. Henry Mangles Denham, 'The "Herald's" Voyage, 1852–61', *Proceedings of the Royal Geographical Society of London*, 6, No. 5 (1861–2), 197–200.
94. For example, the following maps from the Royal Society of Edinburgh Collections at the NLA Maps Library: *Australia East Coast. Sheet XX, Cape Sidmouth to Cape Grenville and the Barrier Reefs surveyed by Captn. F. Blackwood, Lieut. C. B. Yule, Mr F. J. Evans, Master, M. D. Aird, Mate*, H.M.S. Fly *and Captain Owen Stanley, Lieuts. C. B. Yule, J. Dayman, H. G. Simpson & Mr Obree, Master's Assistant*, H.M.S. Rattlesnake, *1843–48* (London, 1855), Bib ID 3791302, MAP British Admiralty Special Map Col./49, https://nla.gov.au/nla.obj-233814368; (acessed 25 January 2021) *Australia, Coral Sea and Great Barrier Reefs Shewing the Inner and Outer Routes to Torres Strait. Sheet 2: From the Surveys of Captains Blackwood, Owen Stanley, and Yule, R. N., 1842–50: The Outer Detached Reefs from Captains Flinders and Denham, Royal Navy, 1802–60* (London, 1860), Bib ID 3790967,

The *Herald*'s cruises comprised the last major hydrographical surveying work undertaken in relation to Australia's coastline and nearby islands. Only isolated, relatively small parts of Australia's shores still needed to be surveyed thereafter. From 1860 onwards, Australia's colonial governments became involved in surveying their own coasts; they supplied ships and crews for this purpose and paid their expenses. Royal Navy officers took charge of the surveys. However, the commitment made by the colonial governments proved temporary: Western Australia declined to participate in these undertakings and Queensland and Tasmania withdrew from the agreements made before their work was completed owing to the costs involved.[95]

Conclusion

Between 1815 and 1860, important improvements were made to both the Inner and Outer routes through the Great Barrier Reef by the voyages undertaken by Phillip Parker King, Francis Blackwood, Charles Yule, Owen Stanley and Henry Mangles Denham. Both the Colonial Office and the Admiralty Hydrographic Office in London initiated these voyages with their own sets of instructions. In each case, the voyages benefited from expert hydrographic surveyors who paid meticulous attention to the effects of winds, currents, tides, soundings, bathymetric readings, passages and channels through the coral rock. These details were all recorded on detailed charts, which the Admiralty released in an engraved form for the assistance of mariners. In 1884, a detailed guide to navigation through the Great Barrier Reef suggested that the Outer Route was preferred by three-quarters of the merchant vessels sailing north from Sydney up the east coast of Australia.[96] However, both the Inner and Outer routes continued to be used by ships in the late

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MAP British Admiralty Special Map Col./5, https://nla.gov.au/nla.obj-233809857 (acessed 25 January 2021); *Australia, Coral Sea and Great Barrier Reefs Shewing the Inner and Outer Routes to Torres Strait. Sheet 1: From the surveys of Captain Flinders, King, Blackwood, Owen Stanley and Yule, R. N., 1802–50; The Outer Detached Reefs, and Line of Great Barrier Reefs from Captain Denham, R. N., 1858–60 Compiled in the Hydrographic Office by Mr F. J. Evans, Master, R. N., 1860* (London, 1860), Bib ID 3790966, MAP British Admiralty Special Map Col./4, https://nla.gov.au/nla.obj-233809740 (acessed 25 January 2021), *Australia, East Coast. Sheet XVII, Double Pt. to Cape Tribulation and the Barrier Reefs by Captn. O. Stanley, Lieuts. C. B. Yule, J. Dayman, H. G. Simpson & Mr Obree, Master's Assist.*, H.M.S. Rattlesnake, *1843–48* (London, 1855), Bib ID 3791299, MAP British Admiralty Special Map Col./46, https://nla.gov.au/nla.obj-233814032 (acessed 25 January 2021); *Chart of Part of the N.E. Coast of Australia. Sheet 1 by Phillip King, Commander, R.N., 1819, 20, 21; With Additions by Commanders Wickham and Stokes, 1839, Captn. F. Blackwood, 1844 and Capt. O. Stanley, 1847* (London, 1847), Bib ID 3791269, MAP British Admiralty Special Map Col./23, https://nla.gov.au/nla.obj-233811831 (acessed 25 January 2021); *Australia, East Coast. Sheet XVIII, Cape Tribulation to Cape Flattery and the Barrier Reefs by Captn. O. Stanley, Lieuts. C. B. Yule, J. Dayman, H. G. Simpson & Mr Obree, Master's Assist.* H.M.S. Rattlesnake, *1843–48* (London, 1855) Bib ID 3791300 MAP British Admiralty Special Map Col./47, https://nla.gov.au/nla.obj-233814143 (acessed 25 January 2021).

95. David, *The Voyage of H.M.S. Herald*, 401; Pearson, *Great Southern Land*, 112.
96. Findlay, *A Directory for the Navigation of the South Pacific Ocean*, 949.

nineteenth century, and it is worth concluding by emphasising what the surveying voyages on both routes had achieved between 1815 and 1860.

More detailed charting of the Inner Route occurred earlier than surveying of the Outer Route because Phillip Parker King was a keen advocate of ship passages between the mainland and the western edge of the reefs. He prepared the first detailed chart of the Inner Route, with sailing directions. This fixed the positions of unknown reefs and shoals, and served as an important *vade mecum* for navigators. Blackwood continued King's work, improving navigation through the northern end of Whitsunday Passage between Whitsunday Island and the mainland and devoting more attention than previous hydrographers to passages where ships could transfer from the Outer to the Inner Route and vice versa. Stanley continued work on the safety of the Inner Route, improving soundings to enable continuous sailing at night and producing accurate charts. Blackwood undertook the first serious survey of the Outer Route, establishing a beacon on Raine Island as a marker for transfer of ships from the Outer Route to the Inner Route. He discovered the Great North East Channel among the most northerly section of the Great Barrier Reef at the northeast entrance to Torres Strait. Stanley and Denham devoted detailed attention to the Outer Route, especially in the Coral Sea and between the top end of the east coast, the Louisiade archipelago and New Caledonia. By 1860, as opposed to 1815, the charts produced by these navigators incorporated most of the hazards for vessels and directions through narrow passages and channels to enable both sailing and steamship vessels to determine their routes through Torres Strait via either the Inner or Outer Route of the Great Barrier Reef.

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