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Maritime Archaeology and Ancient Trade in the Mediterranean

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Contents

Acknowledgements ix

List of Illustrations xi

List of Tables xvii

List of Abbreviations xix

List of Contributors xxi

Introduction: Maritime archaeology and the ancient economy 1
Andrew Wilson and Damian Robinson

1. The shipwrecks of Heracleion-Thonis: a preliminary study *David Fabre* 13

2. Developments in Mediterranean shipping and maritime trade from the Hellenistic period to AD 1000 *Andrew Wilson* 33

3. Ancient sailing-routes and trade patterns: the impact of human factors *Pascal Arnaud* 61

4. Ceramic assemblages and ports *Candace Rice* 81

5. Constructing port hierarchies: harbours of the central Tyrrhenian coast *Katia Schörle* 93

6. Technology, innovation, and trade: research into the engineering characteristics of Roman maritime concrete *John Oleson, Christopher Brandon and Robert Hohlfelder* 107

7. Heracleion-Thonis and Alexandria, two ancient Egyptian emporia *Franck Goddio* 121

8. *Lapis transmarinus*: stone-carrying ships and the maritime distribution of stone in the Roman Empire *Ben Russell* 139

9. Dolia shipwrecks and the wine trade in the Roman Mediterranean *Karen Heslin* 157

10. Location, location, location: characterizing coastal and inland production and distribution of Roman African cooking wares *Victoria Leitch* 169

11. A reconstruction of the maritime trade patterns originating from western Asia Minor during Late Antiquity, on the basis of ceramic evidence *Theodore Papaioannou* 197

12. Maritime connectivity in Late Antique Lycia: a tale of two cities, Aperlae and Andriake *Robert Hohlfelder* 211

Index 223

5: Constructing port hierarchies: harbours of the central Tyrrhenian coast

Katia Schörle

Theoretical background

In an influential theoretical paper on harbour archaeology, Karmon stated 'A port cannot be regarded as an isolated phenomenon, but as part of the political, social and economic life of a region.'[1] It is only within the wider contexts of connectivity and through the economic activities of a region that one can fully begin to understand a port and attempt to grasp the nature of its activities, whether locally or over a wider geographical range. Despite a considerable revival of interest in ancient harbour cities and structures, much analytical and comparative work remains to be undertaken to examine ports in their wider contexts.[2] Substantial projects and harbour excavations (such as those at Caesarea or, more recently, at Portus or Alexandria) focus on the port in itself and owing mainly to the intrinsic complexity of these mega-ports, they have not yet been set into the wider historical contexts and connective networks of other ports on which they depended, and which they supplied.[3] The aim of this paper, therefore, is to develop connective thinking in port studies through a theoretical approach, while focusing on a specific geographic unit: the Tyrrhenian coastline between Cosa and the Bay of Naples.

The port, whether for local or long-distance commerce, functions as a hub between land and sea and several factors affect it. Two in particular are key: a) that the area has good natural harbour facilities; and b) that the physical geographical location generates a certain amount of traffic. Both conditions will vary over time, but more often according to technological progress and economic conditions. The traffic factor is the most important one: excellent natural harbour sites will not be used unless of economic value for the area, whether for local or inter-provincial trade, and harbours will be constructed artificially if needed, according to the level of technology available.[4] The development of ports is therefore driven by trade, but also enables it to grow accordingly. As such, ports are to a certain degree indicators of trade and facilitate its development. Just as our understanding of trade is mediated through the physical evidence of shipwreck cargoes and ceramic assemblages, ports might also be used to understand the economic vibrancy of a coastal region.

As a hub, a port depends as much on its hinterland, the 'area where the traffic demand originates, and which is connected to the port by a set of inland routes'[5] as it does on its foreland, that is, the ocean traffic, and the ports to which it has frequent shipping connections. The hinterland factors can be either consumption or production. The foreland, or ocean traffic, can be conceptualised by means of shipping lanes and routes as proposed by Arnaud,[6] or by models of interaction, such as the one advanced by Nieto, whereby he proposes a pattern of trade between secondary ports and primary ports.[7] This model certainly breaks down the monolithic concept of a port and concedes that, to a certain extent, a port's role is determined by its commercial traffic. One particularly resonant example of interaction between primary ports and secondary ports is that offered by the fourth-century AD ostraca from Carthage, which give details of regular, provincially organised maritime shipments of oil to Carthage from ports along the Tunisian coast, possibly for onward transmission to Rome.[8] In very few instances, however, is it actually possible to show such a clear and frequent example of connectivity between ports.

One clear symbiotic relationship between ports of different size rank is that between Portus and Ostia, two ports which are often conflated as one. While Ostia was Rome's port of transit during the Republican period, with the construction of the Claudian harbour at Portus, bulk merchandise directed to Rome was mainly funnelled through Portus. Portus may be regarded as a provincial and inter-provincial port supplying the needs

1 Karmon 1985: 3.
2 Cf. Blackman 1982a; 1982b; 2008.
3 Keay (forthcoming); Goddio and Fabre 2008; 2010.
4 Karmon 1985: 1.
5 Ibid.: 2. For the purpose of this study, I have not included the evidence from roads in the hinterland. This should not by any means undermine or understate the crucial supportive role of roads for maritime trade and harbours.
6 Arnaud 2007.
7 Nieto 1997: 154–8.
8 Peña 1998. As noted by Heslin in this volume (Chapter Nine), we also have records of organised land transport to Carthage as well. Another valuable example and source are the Murecine tablets from Puteoli (Camodeca 2001), which give details on maritime loans, with the names and origins (and therefore possible main secondary ports trading with Puteoli) of *navicularii* and contractors. See also Arnaud, this volume (Chapter Three).

of a busy interconnected maritime façade and a major redistribution centre. The riverine port of Ostia would have subsequently primarily supplied the local needs of that city. Goods coming in for Rome through Portus clearly went up the Tiber, not down to Ostia, while goods coming in for Ostia, such as corn (by sea) or bricks for the building industry (by river), went to the Ostian port, either directly or transhipped via Portus, to be stored in the *horrea* within the city awaiting further use or sent to ongoing projects in the city. For example, the bricks used in construction work in *Insula* II.vi.3–7 came mainly (57 per cent) from one contractor, Quintus Servilius Pudens,[9] a wealthy second-century *dominus* who owned *figlinae* in the hinterland of Rome. One of these was in the area of Narni,[10] further up the Tiber and Nera rivers; the bricks presumably came directly down the Tiber to Ostia, while lime and wood may have come either from the same area or from Terracina, whence both imports for the public building industry at Rome are attested.[11] Given the size of Ostia and its daily needs, in terms of construction, food supplies, or the daily transit of people, local traffic at its fluvial harbour must have been fairly important.[12] While in terms of hierarchies Portus functioned primarily on a provincial and inter-provincial level and Ostia on a local one, the relationship between the two ports is best illustrated by the presence of several ferry services for the daily commute from one port to the other. These ferry services could either be in the name of an individual, such as the ferry of Lucullus,[13] or what would seem to be several ferries grouped as an organisation, such as the *corpus trajectus*,[14] *corpus trajectus togatensium*,[15] *corpus trajectus rusticeli*,[16] possibly catering to different social groups. They must have served for the daily commute of goods, workers, merchants, and officials, but also for the occasional trip of passengers waiting to embark for further destinations, such as St. Augustine.[17] Even in terms of shipbuilding, Portus and Ostia had their own separate and distinct shipbuilders' corporations.[18]

But other than epigraphic and documentary evidence, what does the evidence for the traffic needs of ports look like on the ground? Models such as those proposed by Nieto are useful conceptually to explain port hierarchies, but they may not grasp any nuances or even explain differences among ports within the same group.

If a harbour space, as a receptacle of trade, is at all representative of the economic role of a port, then we should expect to understand the role of a port to be somewhat reflected in its harbour size and facilities, particularly should its harbour be artificially constructed. Although some imperial lavishing might complicate the picture, actual harbour enclosure sizes (rather than wharves, or buildings) are likely to reflect traffic needs and careful engineering rather than merely ostentatious behaviour.[19] Depth may not necessarily be an issue, since most Roman ships could dock in only three metres of water, but space within a harbour must have been a particularly important issue. It is more than likely that the majority of ships chose to call at ports based on their harbour and docking facilities, as the smaller ports may not have had the adequate facilities for large freighters. Hiero II of Syracuse, who had a super-freighter built, could then not find ports with sufficient berthing facilities for it to be of any use, and hence relinquished the ship to Alexandria, the only other port city capable of accommodating it.[20] Similarly, the regulations at Thasos must have stemmed from an incentive to optimise an already cramped harbour space.[21] Other than demand-driven trade and necessary structures, specific vessels, in particular larger ships, were also not suited for much loading and off-loading at the smaller ports owing to the nature of their cargo arrangements and ballast requirements. The stability and safety of a ship very much depends on its cargo, which is in consequence carefully assembled. A ship's cargo, as demonstrated by McGrail, depends not simply on the seller's selected goods to be sold for profit, but also on the stability needs

9 DeLaine 2002: esp. 60–61.
10 At least, so the name of the *figlinae* (*Narnienses*) would suggest.
11 DeLaine 1996: 178; *Codex Theodosianus* 14.6.3; Symmachus *Relationes* 40.3.
12 Cf. Heinzelmann and Martin 2002 for its location and reconstruction, together with the *navalia* and harbour temple. DeLaine calculates that an average of 7–8 people alone were needed for four years to carry building material from the Ostian dock to the Insula of the Paintings, without counting loading and unloading (1996: 179).
13 *CIL* XIV: 409, 5320, 5380.
14 *CIL* XIV: 45.
15 *CIL* XIV: 403, 4613, 4616.
16 *CIL* XIV: 4553–6, 5327, 5328.
17 St. Augustine *Confessions* 9.8.
18 Konen 2001.
19 '. . . of course one must allow for civic pride, collective or individual, but also for hard-headed financial calculations, particularly when structures needing maintenance were involved. There was no need to build harbours larger or more sophisticated than required', Blackman 1988: 8. As Purcell (1998) noted for the *litus Laurentinum*, however, the issue 'lies within the distinctive ambiguity of the imperial history of the *litus Laurentinum*: the emperor's private business was at the same time the public interest'. (N. Purcell: 'Discovering a Roman resort-coast: the *litus laurentinum* and the archaeology of otium' http://www.rhul.ac.uk/classics/LaurentineShore/ASSETS/PDF-files/Litus%20Laurentinum%20English%20version.pdf; last consulted 4 December 2010). For both reasons of cost and public interest, large artificial harbours often required imperial intervention.
20 Athenaeus *Deipnosophistae* 5.209b.
21 *IG* XII Suppl.: 151, no. 348 = *SEG* XVII. 417; Blackman 1995; cf. also discussion by Arnaud, this volume (Chapter Three).

of the ship.[22] This relationship between stowage factors and ship stability remains a key point in understanding cargo assemblages, but also explains why ships with large cargoes were unlikely to have been involved in much haphazard loading and off-loading at random ports. What we see instead are systems of redistribution from larger ports and emporia.[23]

The maritime façade of the central Tyrrhenian coast

The natural harbourlessness of the central Tyrrhenian coastline posed serious issues for the maritime development of Rome, not solely militarily, but also economically. In order to land goods from larger vessels, they would need to anchor in the shallows and tranship their cargo into lighters for the journey to the shore, a sometimes risky and hence costly process, or else the ships had to seek the shelter and the shallows of suitable rivers.[24] Hence the invention of hydraulic concrete at the end of the third century BC, or in the second century BC, had a dramatic impact on the development of the entire coast, enabling the creation of entirely artificial harbours in areas lacking natural shelter.[25] The construction of a mole by M. Aemilius Lepidus close to Terracina in 179 BC, for example, must have had a considerable impact, opening up the region to wider markets.[26] Harbour structures presumably slowly developed after the discovery of the hydraulic properties of *pozzolana* and reached a climax in the second century AD with several sizeable harbour constructions, notably at Portus and Civitavecchia.[27] The difference in viewpoints between Strabo and Pliny concerning the nature and number of harbours in Italy may also in part reflect a historical reality, despite the rather short chronological distance between the two authors.[28] The creation of Portus Iulius under Agrippa, possibly by the architect Lucius Cocceius,[29] probably set the trend for large man-made harbours on the Tyrrhenian coast, despite its failure due to rapid siltation. Between the second century BC and the second century AD, and peaking in the first century AD, one also notices a considerable boom in the number of villas along the coast between Cosa and Puteoli.[30] These, we will see, supplied distant markets and could be supplied from them, through the development of their own ports, and hence they were able to engage in maritime trade.

Measuring harbour sizes

In order to understand the development of the littoral and the potential roles of ports on the Tyrrhenian coast, size data for ports and harbours on the stretch from Cosa to Puteoli were recorded. This limits us to enclosed coastal spaces and cannot include river ports which, though important for the Tyrrhenian shores in the Republican period, seem gradually to have taken second place to coastal ports in the Imperial period. Ideally, one would like to know wharfage lengths for all harbours, as that would be the most directly useful measurement for estimating the numbers of ships that could dock simultaneously, but this is in most cases not possible. Where we have them, we can attempt this: the detailed calculations of ship capacity for Portus have been dealt with in a joint paper elsewhere, but perhaps we may just highlight that with the construction of its harbours and canals, Portus was the largest artificial harbour structure of the Mediterranean and could probably host some five hundred ships in its basins, and crucially, it had *c.* 13,900 m of wharfage space.[31] But most of the time wharfage lengths are not available, so the area of a harbour has to be used as a proxy, since area data are much more widely available. While there is no simple relationship between area and docking space, generally a larger area will have more docking space around its edges, more space for jetties, and will have a larger sheltered anchorage space for ships waiting to dock. So area is a reasonable proxy for this general analysis. Harbour areas overall must be carefully designed to optimize space, protect ships within the harbour from winds and currents, but also to allow an easy entrance and exit according to winds, as we will see in the case of Civitavecchia. Too large a harbour basin might be dangerous. The wrecking of two hundred ships during a storm in the Claudian basin at Portus

22 McGrail 1989.

23 Nieto 1997; Wilson *et al.* forthcoming; Arnaud, this volume (Chapter Three).

24 Strabo *Geographica* 5.35; Pliny *Epistulae* 6.31; Dionysius of Halicarnassus *Antiquitates Romanae* 3.44 on ships with more than 3,000 amphorae having to anchor out at sea.

25 Oleson *et al.*, this volume (Chapter Six).

26 Livy *Ab Urbe Condita* 40.51.2.

27 Blackman 1982b: 193.

28 For Strabo, Italy is mostly harbourless but at least has big ports (6.4.1); for Pliny, Italy's shores are abounding with harbours (*Naturalis Historia* 37.201). Between the death of Strabo and Pliny's statement, at least three large new harbour spaces were created between the Bay of Naples and Rome alone (the Claudian harbour at Portus, Anzio, and the Lago di Paola were connected), and further small harbours probably sprung up as well. For the coastal situation and tenth- to eighth-century BC Etruscan harbours and siltation by the third century BC, Frau 1985. Some were incorporated into Roman structures (eg., at Castrum Novum, into a *piscina*), others may still partially have been in use (e.g., Graviscae, modern Porto Clementino).

29 De Caro 1991: 376. The naval fleet had to be moved to Misenum instead by the time of the Battle of Actium.

30 Marzano 2007: esp. appendices B and C for a quick chronological overview.

31 Wilson *et al*. forthcoming. See also Wilson, this volume (Chapter Two) for North African mole sizes.

might in part attest to design problems with the first ambitious artificial harbour constructions, since large open spaces are prone to high waves and currents, which can be dangerous for ships at anchor.[32] The Eastern Port of Alexandria, although it comprised well over 226 ha, did not have this problem of large open spaces: natural islands and artificial moles and breakwaters within the harbour divided its space, and probably hindered the formation of high waves in the port as well as afforded more shelter from the wind.[33]

While admittedly a crude measure, a rough estimate for harbour sizes is generally available for the largest number of harbours and does provide a tool for a preliminary categorisation that may in some cases be tested against evidence of facilities or infrastructure where they survive. Measurements of harbour sizes were obtained using the software program *TakeOff Live* for those harbours for which relatively reliable plans with a scale could be found. *TakeOff Live* allows one to compute the area of an irregular polygon digitised from a plan with a known scale. The analysis is necessarily limited to ports with both published plans and scales. Margins of error will also inevitably be dependent on the accuracy of any particular map used. In order to calculate the harbour areas, the plans were scanned, and the harbour basin was outlined. The program calculated the area of the basin thus defined and the data obtained were recorded in Table 5.1. These measurements should by no means be seen as comprehensive, and it is hoped that they will spark further work comparing, expanding and refining the dataset. For comparison, a few major harbour sizes from elsewhere have also been added. The port measurements pertaining to our area were then plotted on a map of Italy (Figure 5.1).

Table 5.1. Comparative harbour sizes.

Site	Harbour area (ha)	Wharfage length (m)	Reference
Portus (total)	234	*c.* 13,890	Keay 2011 (Chapter 2, n. 65); Morelli *et al*. in press.
Claudian basin	*c.* 200	2,860	Wharfage figure includes various canals.
Trajanic hexagon	33.3	2,100	
darsena	1.08		
Alexandria, Portus Magnus	> 226	12,380	Calculated from plan in Goddio and Fabre 2008: 38.
Puteoli (total)	67.9		Calculated from plan in Brandon *et al*. 2008: 376 fig. 1.
Puteoli (Portus Iulius)	53.9		Calculated from plan in Brandon *et al*. 2008: 376 fig. 1.
Puteoli (Portus Baianus)	14		Calculated from plan in Brandon *et al*. 2008: 376 fig. 1.
Antium	25-30		Felici 1995: 61.
Ephesus	*c.* 18–24		Calculated from Google Earth.
Caesarea Maritima (outer basin)	20		Oleson 1988: 152.
Hadrumetum	20		Bartoccini 1958: 12.
Centumcellae	14	No more than 2000	Calculated from plan in Caruso *et al.* 1991.
Carthage (circular and rectangular harbours)	14		Romanelli 1925: 92.
Terracina	11		Calculated from plan in De Rossi 1980: 100, fig. 25.
Lepcis Magna	10.2	1200	Bartoccini 1958: 12–13.
Torre Astura	7.8		Calculated from Marzano 2007: 49, fig. 5.
Kenchreae (Corinth)	3		Kingsley 2004: 140.
Cosa	2.5		Gazda 1987: 75.
Giglio Porto	*c.* 2		Calculated from plan in Ciampoltrini and Rendini 2004: 138, fig. 6.[a]
La Mattonara	1.24		Calculated from plan in Higginbotham 1997: 94, fig. 18.
Villa port at San Simone	0.84		Degrassi 1955: 136.
Ventotene (Pandateria)	0.7		Franco 1996: 297.

a The units of the scale bar of this plan are not specified and the plan has clearly been greatly reduced from the stated 1:20000 scale; checking against Google Earth indicates that the scale bar must represent 30 m in 2 m and 10 m units.

32 Tacitus *Annales* 15.18.2.

33 Cf. Goddio, this volume (Chapter Seven); Fabre and Goddio 2010: fig. 5.1.

One thing emerges from the table and map: while the mega-ports of Portus, Alexandria, and to a lesser degree Puteoli, not only dominate the rankings in terms of area and are clearly exceptions, there is also a wide range of harbours available and of harbour sizes of both cities and private villas—between *c.* 1 ha to 30 ha—which seem to represent the norm in port sizes. Their frequency within the area examined indicates a vibrant coastline, as well as economic choices based on the presence of maritime traffic in need of such structures, and cities or individuals willing to invest accordingly. The calculations and comparison of harbour sizes facilitate a more nuanced discourse on the role of ports and their relative role. Puteoli and Portus are most frequently discussed, yet there were certainly other relatively large ports on the Tyrrhenian coastline, such as Anzio, Civitavecchia and Terracina. Although Terracina is smaller than both Anzio and Civitavecchia, its role as a major port is implied through direct comparison with other major ports elsewhere, such as Lepcis Magna in Tripolitania, to which it is comparable in size.

Major ports

Among the mid-Tyrrhenian ports other than at Portus and Puteoli, the imperial projects at Anzio and Civitavecchia particularly stand out. Often discredited as a folly, Nero's harbour at Anzio represented a major investment,[34] not only in the physical structures, but also in the regional economy. Recent studies by Felici have shown that the ancient harbour was much larger than previously thought.[35] With a harbour enclosure between 25 and

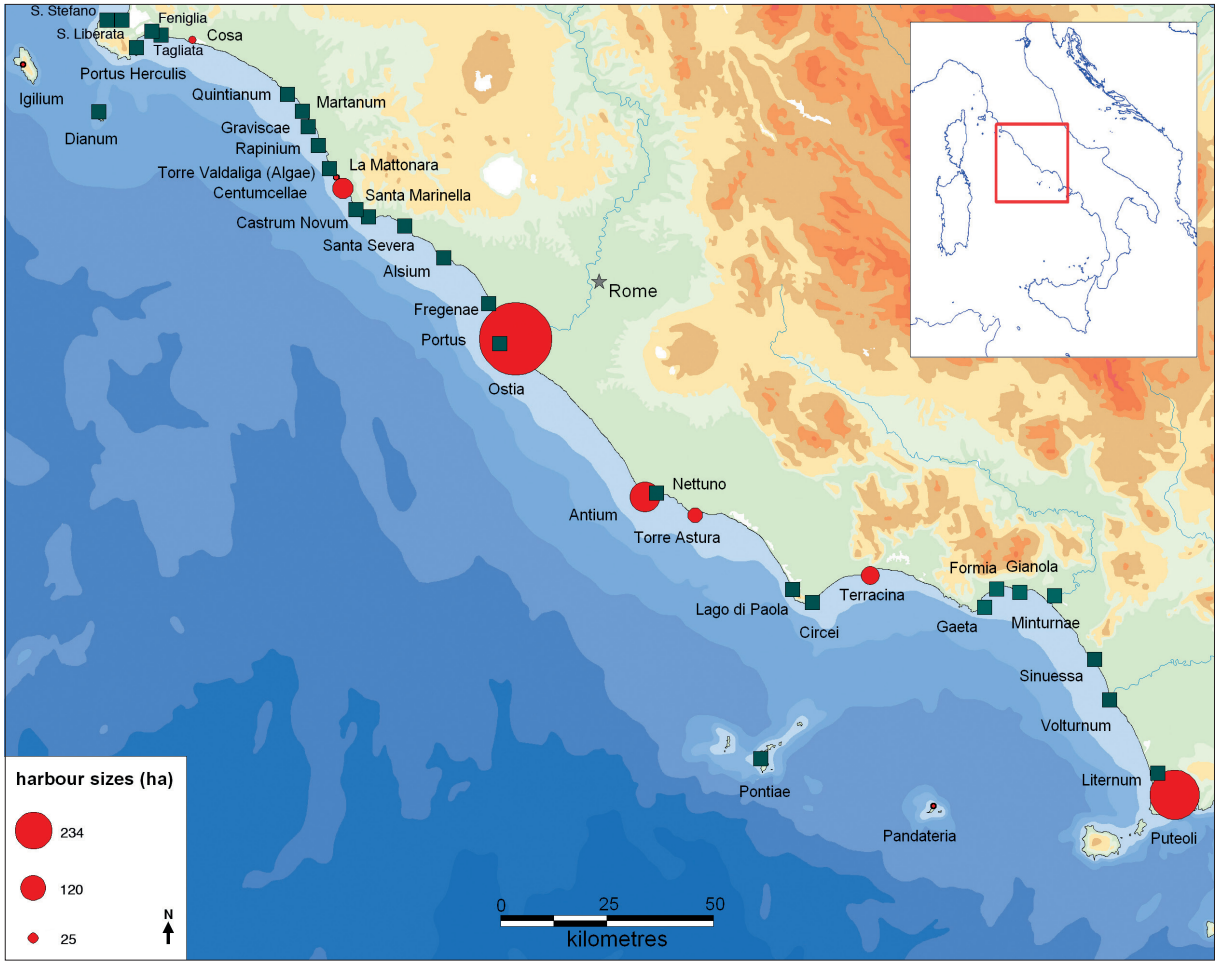

Figure 5.1. Coastal map of the Central Tyrrhenian region, showing the data collected on Roman ports. Harbours with known sizes are indicated in red. Yellow squares indicate ports for which no harbour size data were available. (Map: K. Schörle.)

34 Suetonius *De Vita Caesarum*, Nero 9 *ubi et portum operis sumptuosissimi fecit*, 'he also built a harbour there at vast expense'.

35 http://www.mclink.it/assoc/assonet/arcart/it9502.htm (last consulted 25 August 2010) and Felici 2001; the eastern basin at Anzio was previously thought to have been constructed by Pope Innocent XII, but careful review of the evidence has shown it to be built on Roman remains.

30 ha, making it third in rank after Portus and Puteoli, the role of Anzio in provincial and inter-provincial trade, as well as the impact on its hinterland, should be reconsidered, particularly in the light of Nero's other ports and canal projects.[36] Civitavecchia, the construction of which was witnessed by Pliny, also happens to be among the best-preserved harbours. Relatively little discussed compared to Portus, its size and proximity to Rome caused it to remain of importance throughout the Renaissance once Portus silted up, and it has remained Rome's main port to this day. The structure of this port, with its protected main harbour basin and a trapezoidal *darsena* (inner basin) measuring *c.* 300 × 350 m, probably for loading and unloading ships,[37] benefited from the experience of the contemporaneous Trajanic constructions at Portus, and aimed both to optimize port access[38] and perhaps also to prevent currents and siltation, to ensure the harbour's functional longevity. At Portus, studies of water currents within the enclosure have shown that the hexagonal shape of the enclosure optimises water movement and prevents siltation;[39] it would be interesting to see if other enclosures aimed at a similar goal, particularly Civitavecchia's harbour. In general, Trajan's works seem focused on improving facilities: the hexagonal enclosure was built as an addition to the Claudian harbour in order to maximise loading and offloading facilities, but perhaps also to remedy the problems of the Claudian harbour, which was too large and not sufficiently protected from winds and water movements within the basin to be effectively safe for loading and off-loading. Similarly, a dedication by Trajan at Ancona tells us of harbour works there made specifically for the increased safety of the port.[40]

Several reasons can be identified for the developments at Civitavecchia. Despite the construction of an imperial estate close by, the harbour facility's function goes beyond that of private imperial needs. Most probably Civitavecchia and Terracina were intended as satellite harbours for Portus.[41] Quilici and others rightly note that, from its very conception to the present, it has been one of the safest harbours on the middle and upper Tyrrhenian coast.[42] Pliny emphasises both the harbourlessness of this stretch of coast and the benefits that this port will bring.[43] Again, it is the element of safety that Rutilius Namatianus, writing in the fifth century AD, picks up to describe the port: deviating towards Centumcellae owing to a strong wind, there he finds ships safely at rest, with neither waves nor winds disturbing them.[44] Providing a safe harbour at a strategic location on the coast must have been an important consideration.[45] In the second century, Rome was well provided by Portus and it is possible that Centumcellae, as well as providing facilities for Trajan's villa, and for naval detachments,[46] was also intended to provide the area with an adequate harbour to boost the local economy in the productive area north of Rome. The region just north and south of Civitavecchia was known in antiquity for its wine productivity: we know of grafting experiments for increased productivity in the area of Caere,[47] and from Pliny about production at Graviscae, just north of Civitavecchia.[48] It has indeed been suggested that the late first- and second-century popularity of Caere wine might partially be attributed to the presence of the new harbour.[49] Similarly, the South Etruria survey identified a concentration of villas and substantial cisterns for irrigation probably of fruit, vegetables and vines to the north of Rome, around Fidenae and Crustumerium. The largest cisterns and cistern concentrations, however, were located on the Northern side of Lake Bracciano, some 40 km away from Rome,[50] that is, sufficiently far enough from

36 http://www.mclink.it/assoc/assonet/arcart/it9502.htm (last consulted 25 August 2010).

37 Quilici 1993: 66.

38 Ibid.: 68.

39 Tronchère, H., Millet, B., Goiran, J. P., and Boetto, G. 'Portus: Water currents modelisation and geoarchaeology' paper presented at the Current Research at Portus workshop, 24th February 2009, British School at Rome.

40 *CIL* IX: 5894. Canals were another way of improving maritime and fluvial trade, making it safer and quicker, e.g., Trajan's canal at Clysma on the Red Sea, or that at the Iron Gates on the Danube.

41 Rickman 1991: 109.

42 Quilici 1993: 63. For comments on the shape of the entrance, its studied attention to winds and careful construction allowing ships to enter easily even during strong winds, cf. p. 68.

43 Pliny the Younger *Epistulae* 6.31: *habebit hic portus et iam habet nomen auctoris eritque vel maxime salutaris. Nam per longissimum spatium litus importuosum hoc receptaculo utetur.* 'This harbour will bear and indeed already bears the name of its maker, and will assuredly prove to be a place of safety for the long stretch of harbourless coast which will now enjoy its shelter' (trans. K. Schörle). This comment clearly refers to public safety and use, rather than a merely private one.

44 Rutilius Namatianus *De Reditu Suo* I.237–49. The point is made quite strongly at I.246 *instabilem fixis aera nescit aquis*, given that they had to seek refuge from strong winds: *ad Centumcellas forti defleximus Austro* (I.237).

45 Incidentally, the entirely artificial harbour at Caesarea Maritima is also mentioned by Josephus in terms of safety, but the passage also seems to highlight the future economic potential of the port (Josephus *Bellum Judaicum* 1.407–8).

46 Bastianelli 1954: 25–7, 88–91 for inscriptions of *classiarii* from Misenum and Ravenna.

47 Columella *De Re Rustica* 3.3.3, 3.9.6: 'for the thing that happened in our Ceretanum seems to have been in the nature of a prodigy, in that a certain vine on your place exceeded the number of two thousand clusters, and with me, that eight hundred pounds grafted stocks of less than two years yielded seven *cullei*, or that first-class vineyards produced a hundred amphorae to the *iugerum*'.

48 Pliny the Elder *Naturalis Historia* 3.60, 14.67.

49 Marzano 2007: 164, and n. 38.

50 Wilson 2009: esp. 746, and fig. 11.

Rome to consider maritime transport of perishable goods as a possible alternative to land transport. This would also have opened these regional products to markets other than that of Rome, where imports of wine in particular from the entire empire would have potentially reduced the market share for each type of wine.

To the south of Rome, Terracina, which had an 11-ha harbour and 1,200 m of docking space,[51] that is, comparable in size and docking space to the port of Lepcis Magna, may also have been involved in wine shipments. The famous *caecubum* wine from the area of Fondi, from a small and agriculturally very fertile plain between the Ausoni and Aurunci mountains and the coast, could have been exported from either Terracina or even Gaeta, which both had harbour repairs undertaken by Antoninus Pius, along with Puteoli.[52] The mole built at Terracina by M. Aemilius Lepidus may be related to an intensification of wine production in the area and a wish to facilitate exports, and likewise an incentive for both.[53] The extensive land reclamations and drainage systems in the Fondi plain at Pantanello, and perhaps two other nearby sites, in the first century BC have been suggested as agricultural improvements linked with high returns and show a continued development of the area.[54] The Dressel 1B amphorae that were found in the Madrague de Giens wreck, a first-century BC ship from southern Gaul capable of holding 4,500–6,500 amphorae, were identified as having been produced in the region of Terracina.[55] By the second century AD, with Trajan's works on the Appian way and improvements to the port, Terracina was particularly well-connected by land and sea.[56] Terracina remained an important harbour, not least because of its aforementioned role as timber and lime supplier for the construction industry at Rome, its famous sanctuary perhaps attesting to its continued general wealth.

Grey areas of knowledge: the case of Minturnae and lesser known ports

Often overshadowed by its bigger neighbour, Puteoli, Minturnae's harbour is an example that falls through the net of a systematic application of the harbour measurement model, as its ancient size could not be gauged: the city relied on an inland riverine port which has been studied and excavated, but unfortunately its river-mouth harbour now lies beneath a cement factory.[57] In terms of harbour/maritime structures, fifteen shipsheds were found at Minturnae,[58] as well as an inscription recording the presence of an *architectus navalis*, suggesting possible ship-building in the area.[59] Pitch-making and a pitch-maker's guild is equally attested, both in the epigraphy and archaeology.[60] Pitch was mainly used for caulking ships and for sealing transport containers such as amphorae and barrels. Pitch-making was probably a local industry. Sherds of *kadoi* (pitch containers) found in an industrial quarter *c.* 30 km upstream of Minturnae, together with the aforementioned inscriptions of the *socii piciarum*, suggest local pitch-making.[61]

Other than a possible lumber industry linked to pitch-making, and salt production,[62] Minturnae's thriving seafood industry is most entertainingly alluded to by Athenaeus's story about the wealthy Apicius, who spent his time eating high-priced Minturnian prawns, apparently the largest to be found in the empire.[63] Minturnae probably flourished both on the agricultural production of its hinterland and on resources from the sea, coupled with the ability to tap into wider long-distance maritime systems. The involvement of Minturnae in substantial long-distance trade in Campanian wine, for example, is addressed by Heslin's study of dolia shipwrecks in this volume (Chapter Nine). One interesting suggestion is that L. Burbuleius from Minturnae, curator *rei publicae* at the ports of Narbonne, Ancona and Terracina, may have obtained his posts after training at the port of his home city.[64]

Much less can be said overall about other smaller city harbours, in particular those which have been little studied and for which documentary evidence is relatively scarce. Wine from the *ager falernus*, for example, was once sent out of Sinuessa,[65] before it declined in importance and Minturnae was used instead.[66] One incentive boosting the economy of port cities along this

51 De Rossi 1980: 100, fig. 25; Blackman 2008: 648–50.
52 *CIL* X: 831, 1640–41; *SHA Antoninus Pius* 8.3.
53 Gianfrotta 2008: 72; Livy *Ab Urbe Condita* 40.51.2; for the suggestion that it may be connected to exports of wine from his estate: D'Arms 1981: 36; Tchernia 1986: 63.
54 Wilson 2000: 316.
55 Tchernia *et al.* 1978: 104; Hesnard 1977.
56 Marzano 2007: 164.
57 Its potential importance, however, was already noted (Johnson 1933: 128).
58 Blackman 1988: n. 32.
59 *CIL* X: 5371. The inscription was found further upstream in the locality of Santa Cosma e Damiano, c. 10 km from Minturnae.
60 Johnson 1933: n.1, 7, 14, 16, 19.
61 Cavassa 2008: 105–6. Although as the author points out, imports from the famous pitch-producing region of Bruttium cannot be entirely excluded.
62 Johnson 1933: nos 14, 16, 21, 26. Salt-production probably relates not only to local consumption but also to the shipping industry, as salt was the principal method of food preservation in antiquity.
63 Athenaeus *Deipnosophistae* I.7.a–c.
64 Ruegg 1988: 212; *CIL* X: 6006.
65 On the *ager falernus* wine production, and amphora kilns found in the hinterland of Mondragone, Panella 1980. On the terminology and problems of the use of the term *falernian*, Panella 1980: 251–2; on its probable falsification, Tchernia 1980: 309.
66 Marzano 2007: 162.

coastal strip must have been Claudius' privileges granted to citizens lending a ship capable of carrying 10,000 *modii* (65–70 tonnes) to the *annona* for six years; later, in the second century AD, ship owners were exempted from *munera* as long as they had one ship of 50,000 *modii* or five ships of at least 10,000 *modii* each in the service of the *annona*.[67] This must have significantly reduced shipping costs and further developed the economy of coastal areas, particularly if it also provided an incentive for individuals to buy ships. It is probably safe to assume at the very least that the majority of ships frequently commuting for the *annona* between Puteoli and Rome also benefited from engaging in additional coastal trade.

Islands off the coast

Islands may be considered in their own right, as their maritime facilities were often their chief economic asset, connecting the island into wider maritime networks. Islands therefore often played a key role as ports of call along the major maritime trade routes. Good protective shelter and revictualling facilities were probably their main attractions. In some cases, harbours were created *de novo*, as at Ventotene, ancient Pandateria, for which some 60,000 m^3 were cut out of the rock.[68] *Horrea* were also carved from the rock for the temporary stocking of goods.[69] Functioning harbours regardless of weather or wind conditions were an attractive asset for islands. Giannutri (Dianum) had two harbours—Cala Maestra and Cala Spalmatoio—one on each side of the island, providing shelter whatever the wind direction. The eastern and most important one, Cala Spalmatoio, was also flanked by a cistern in order to provide ships with fresh water supplies:[70] supplying water and temporary goods was a principal activity for these island 'pit-stop' ports. At Ponza, the two harbours were connected by a 128 m long tunnel; one could come in and depart from a different harbour depending on wind conditions.[71] Estates on islands had docks capable of handling heavy cargoes: iron was exported from Elba and granite columns of considerable size from the island quarries on Giglio (Igilium).[72] These would have required a good dock and harbour cranes. Seventeenth- and eighteenth-century documents attest to the remains of at least 105 m of the ancient mole at Giglio,[73] which could serve as a docking area as well as a loading platform.

Shipwrecks found around islands such as Giglio, Ventotene, or Zannone also testify to the islands' proximity to and role within major commercial axes.[74] While harbours provide the ultimate safety, the main concern during stops would have been protection from winds while at anchor and reliable supplies of water and food. For some of these islands, their advantage lay both in natural crater depressions and the resulting protection from winds, which made for excellent mooring: the Pontine Islands for example, are remnants of extinct volcanoes and their crescent shape would provide particularly good shelter against winds. The same can also be said of Giannutri, whose natural shape and bays would have protected ships particularly well from north-north-westerly winds.

Villa harbours

Almost never discussed for their harbours, the potential role of coastal villas in maritime trading systems has not been examined sufficiently. Maritime villas often had a private port or at the very least a dock or jetty; one could arrive by land or by sea. This also meant that the cheaper maritime transport, particularly for bulk goods, must have been a preferred option, and can be seen from the practice of shipping agricultural goods described by the *Lex Claudia*. This law of 218 BC forbade senators and senators' sons from having sea-going ships able to carry more than 300 amphorae. This equates to the amount considered reasonable to carry from one's fields, which tells us that maritime shipments of agricultural goods must have already been a fairly common practice anyway. While ship owners on the whole were generally of modest social status and wealth,[75] this did not prevent the elite from either lending money for the initial investment, or indeed developing at least safe docking and shipping infrastructure. Goods transported on the ship were often of higher value than the ship itself [76] and their safety at the most risky stage of transport, namely loading and

67 Rickman 1991: 105; Kehoe 1988: 2, and fn. 3.
68 Schmiedt 1972: 177.
69 These are still visible. On the possible presence of shipsheds at Ventotene: Blackman 1988: 15.
70 Ciampoltrini and Rendini 2004: 142.
71 Marzano 2007: 42. On the Roman port and its mole at Ponza, Gianfrotta 2002: 67–75.
72 Ciampoltrini and Rendini 2004: 140.
73 Ibid.
74 Seeking refuge in the lee of islands might be a last resort for ships not able to make it to land. At least 20 wrecks are known around Giglio (Parker 1992: 191–3 and references for the other 14 shipwrecks around the island). Ventotene: Parker 1992: 90–1, 206–7, 351, 446; for the five newly discovered Ventotene wrecks, see http://news.bbc.co.uk/1/hi/world/europe/8168425.stm (last consulted 25 August 2010); for Zannone http://uk.reuters.com/article/idUKTRE66O0HF20100725 (last consulted 25 August 2010). Seeking shores during a storm might be a risky choice, as ships can end up smashing against the shore's rocks or reefs.
75 At least according to bottomry loans (Rathbone 2003: 203–5). For transport between small villa ports and major ports, villa owners probably used their own ships, or those of their slaves and freedmen.
76 The cost of buying a new 300-tonne ship was equivalent to that of a cargo and a half of wheat. Similarly, the goods mentioned in the Muziris papyrus, which concerned only a fraction of an incoming cargo, were thirty times more expensive than a ship of that size (Rathbone 2003: 211).

offloading, was therefore paramount. On the whole, ports on villa estates have been noted with more or less detail, but never in the context of maritime trading.[77] This is essentially due to an earlier scholarly emphasis on the maritime villa as a luxury estate, fuelled by an abundant ancient literature on extravagant uses of fishponds and fish. But although they have often been seen as villas of pleasure for the wealthy, the recent review of *villae maritimae* by Marzano finally highlights their role also as economic enterprises.[78] Given that some private harbour dimensions are known, it is worth making a few comments about their sizes and potential role. First, it is to be expected that private villa harbours in particular do not have a clearly straightforward relationship to their economic potential: part of their aim was to cater to the lifestyle wishes of the wealthy and thus any potential relationship between size and economic role might become distorted. Nonetheless, once a harbour is in place, it can be used for pleasure or commerce, activities which are not mutually exclusive, particularly in the Roman world. In some cases, the harbour may even have been built for commercial purposes: at Ephesus, the philosopher Damianus had harbour structures built at his coastal estate, which were protected by artificial islands and moles, and this specifically for passing commercial vessels.[79] One wonders to what extent these private harbours could also have been used to avoid port taxes: in Chariton's *Callirhoe*, thought to be written in the first half of the first century AD,[80] the pirate Theron's excuse for selling a slave girl (and not a free woman) and not having docked at Miletus is that he wanted to avoid customs officials, to which his potential buyer replied was that it was all the better so, since Theron also happened to be anchoring on his own estate.[81] Surprisingly for their size-range (one would expect private harbours to be negligible), they appear as not necessarily insignificant elements in the port networks, with harbours that could reach at least seven ha in size. The smallest harbour recorded on the examined stretch of coast is 0.7 ha in size, on the island of Ventotene; its current maximum ship allowance is nonetheless 40 ships of 12 m length.[82] Similarly, if we contrast these ports with earlier known Phoenician or Punic *cothons* or artificial harbours meant to serve cities, these investments are considerable: Punic harbours whose sizes are known (Motya is 0.18 ha in size; Mahdia: 0.78 ha, so in the size range of Ventotene) fall within the lower size range of Roman private harbours.[83]

Even though I would argue that villa production was considerable and lucrative, shipments sent from each estate did not necessarily involve very large ships: we can infer from the *Lex Claudia* that these shipments of agricultural goods were probably already in the order of 200–300 amphorae by the time of the law; the use of a middleman meant that a senator could by-pass the issue of maximum cargo allowed if necessary. Given the short distances to Rome (Anzio and Centumcellae, for example, were both one day's sailing from Ostia/Portus), organised regular small shipments of this size on a weekly basis may well have been the norm.[84] This is not so different from the recorded oil shipments to Carthage in the fourth century AD, which were on average 200–215 amphorae each, less, incidentally, than the cut-off limit for senators, but also just an average-sized ship full.[85] The increase in ship sizes encouraged further maritime entrepreneurial activities and probably sparked a concern for safer enclosures to protect the greater investments in both capital and goods.[86] It is thus to be expected that the number of large privately owned ships in Latium and Campania increased as a result of the law. The cost of keeping a ship in a port or at dock is not known, but it is conceivable that space might have been a problem. Keeping one's ship in a city port, over winter for example, but also during the high commercial season, might have been expensive. Owning a private harbour could, therefore, have been quite advantageous. It is

77 Cf. for example, Degrassi 1955 for Istrian villa ports, which are particularly well-studied in comparison to other areas, and Salza Prina Ricotti 1972–1973: 76–7 for a brief note on those around Lepcis. In southern Gaul, the harbour of the villa at the Anse des Laurons (Ximenes and Moerman 1988) should be noted, in particular due to its exceptional size (10 ha, i.e., the size of the harbour of Lepcis Magna).

78 Marzano 2007.

79 Philostratus *Vitae sophistarum* 2.23: '. . . ἐνδὲ τοῖς ἐπὶ θαλάττῃ καὶ νῆσοι χειροποίητοι καὶ λιμένων προσχώσεις βεβαιοῦσαι τοὺς ὅρμους καταιρούσαις τε καὶ αφιείσαις ὁλκάσιν . . .'. 'And for his estate by the sea-shore he made artificial islands and moles for harbours to secure safe anchorage for cargo boats when they out in or set sail'. The harbour facilities must have been built at some point in the second half of the first century AD.

80 Tilg 2010: 36–79, esp. 79.

81 Chariton *Callirhoe* 1.13.4. This situation would have been a clear breach of the customs law of Asia Minor ll.117–22, § 51–52 on the import of new slaves into the province (Cottier *et al.* 2008: 73).

82 http://www.pagineazzurre.com/italian/porto/id_laz039/porto_i.-di-ventotene-porto-romano-porto-vecchio.htm (last consulted 25 August 2010).

83 As pointed out by Wilson, this volume (Chapter Two) and Wilson *et al.* (forthcoming).

84 Counting one day for loading, one for offloading, one day at a weight station, and *c.* two days of travel (out and back). The market may also perhaps not have been able to absorb more anyway without affecting sales prices for those particular wines.

85 Peña 1998. These may have either been shipped together with other cargoes, or in very small ships. Both cases are not mutually exclusive, the only difference being the archaeological visibility of the former rather than the latter.

86 In a similar way, despite the promise of considerable gain due to a grain crisis, Claudius's promise of insurance against loss during winter travel must have been felt as necessary in order to ensure a protection against risk for these heavy investments in capital. For the cost of financing a ship, Jones 2006: 176–8.

perhaps as a result of a combination of some of these elements that villa harbour constructions come into consideration: interestingly, in some cases villas actually swallowed up city ports. At Cosa, after the decline of the town in the early first century BC, and at Torre Valdaliga, coastal villas took over the earlier Republican ports into their property.[87] Rutilius Namatianus's comment on the stretch of coast between Alsium and Pyrgi, where large villas have replaced small towns, though rhetorical, is quite suggestive of a similar shift.[88] Smaller harbours, such as Punta San Paolo, with an area of 0.13 ha, would seem to be representative of a harbour for private use. The larger ones, however, of several hectares, other than simply being considered ostentatious, may suggest a different picture, if we compare them to the harbour facilities at Cosa. The port at Cosa, 138 km northwest of Rome, was a thriving port in the second and first centuries B.C. Its harbour enclosed 2.5 ha, comparable in size to Kenchreae, the eastern harbour of Corinth.[89] After the decline of the city in the early first century B.C., the harbour seems to have been closely connected to maritime villas and many fish tanks of a maritime villa are known close by.[90] The amphorae assemblages suggest that the port was then a major export point, especially for the business of the Sestii: 86 per cent of the stamps found at Cosa are Sestius stamps.[91] Sestius amphorae have also been identified north of the Skerki Bank Reef, on a busy route between Carthage and Rome,[92] but also on many sites in Northern Italy, and Southern Gaul.[93] Although more docking structures were close by, at the Feniglia Tombolo,[94] probably increasing Cosa's potential, this reminds us that the smaller harbours should not be necessarily be overlooked in terms of importance for commerce and long-distance trading. In the case of the Circeo area, where no sea port is close by, the Lago di Paola, nowadays covering 400 ha and still in use, was connected in the first century AD by a 700 m long and 16 m-wide canal,[95] which gave it an advantageous position as a harbour, particularly for the owners of villas nearby.[96] The lake could have served as a convenient and safe harbour if needed for ships sailing between Puteoli and Ostia, while offering the owners of the villas nearby the ability to import or export goods, or simply to keep their ships at anchor during periods of inactivity. It is perhaps also not incidental that the area of Circeo invested heavily in maritime resources, had salt-water fishponds, purple dye and *garum* industries and was renowned for its oysters.[97] These products were perfectly suited to brackish waters, could be made with a quick and safe access to the sea and did not necessarily have to be consumed locally, but could conveniently be exported.[98]

The key advantage of these maritime estates, other than scenery, must have been in their ports and their relative closeness to the sizeable market of Rome. The concentration of large fishpond villas around Rome does suggest a market opportunity for the sale of live fish.[99] A potential fruit and vegetable production has been suggested for the large south Etrurian farming estates;[100] this can be extrapolated to the maritime villas and an investment in perishable fruit and vegetable production for the markets of Rome and Ostia can be imagined for a good strip of the coastal villas.

While investments in jetties and quays give an idea of docking space available,[101] they are unfortunately less likely to be visible in the archaeological record unless made of concrete or of amphorae.[102] At Punta San Paolo, one of the smallest private harbours recorded, the three-metre square concrete pier would provide an adequate platform for a wooden pier or a jetty for boats loading a fresh fish cargo to be sold in the neighbouring area, or docking while supplying the villa.[103] La Mattonara, located only three km from Centumcellae,[104] had potentially *c.* 190 m of docking space available, if one used the arm protecting the port as a dock. The harbour

87 Schmiedt 1972: 65.
88 *De Reditu Suo* I.223–4: '*Alsia praelegitur tellus Pyrgique recedunt / nunc villae grandes, oppida parva prius*' 'the Alsian land is skirted, and Pyrgi fades into the distance—today large country houses, in earlier days small towns'.
89 Gazda and McCann 1987: 137.
90 Ibid.: 155.
91 Will 1987: 174–5.
92 McCann and Freed 1994: 67–8, 89.
93 McCann 1985: 150, fig. 39.
94 Fentress E. (2009). Review of: 'Hohlfelder, R. (ed.), 2008. The maritime world of ancient Rome: proceedings of 'The Maritime World of Ancient Rome' conference held at the American Academy in Rome, 27-29 March 2003': http://www.ajaonline.org/pdfs/book_reviews/113.1/10_Fentress.pdf (last consulted: 25th August 2010).
95 Schmiedt 1972: 120.
96 I have not included the lake in my harbour calculations, as it is not an artificial coastal basin, and was never planned as an enclosure seeking to optimize space in relationship to its traffic.
97 Marzano 2007: 41 and fn. 113, 50–51 and 61–2.
98 Hitchner 1999: 377 fn. 6 for the interesting suggestion of the practice of exporting live oysters in wicker baskets to increase their market range.
99 Marzano 2007: 55.
100 Wilson 2009.
101 In comparison, ships at anchor require considerable space; optimal anchor conditions already generally require the anchor rope to be at least more than twice if not three times the actual depth, to allow the ship at anchor to move according to wind, tide and local currents.
102 Jetties were sometimes made of amphorae, e.g., the 60 m jetty at Myos Hormos on the Red Sea (Peacock and Blue 2006: 17).
103 Marzano 2007: 355.
104 Ibid.
105 Ibid.: 48–50.
106 Ibid.: 69 and fig. 7.

at Torre Astura was over seven ha in area, that is, twice the size of the harbour at Cosa and probably served both local imperial needs and those at Rome.[105] The presence of satellite farms and estates in the hinterland may indeed indicate a link between production and export.[106] However, for many of the private villa harbours, we do not have evidence for their trade, such as the amphora stamp evidence we have from Cosa. The physical capacity of these harbours suggests that they had the potential for playing an important local role, and that the relative importance of Cosa in the literature respective to Torre Astura or Gianola may simply rely on archaeological visibility and the type of commerce of the one versus the other. The size and presence of harbours, however, is suggestive of the number of moderately large vessels able to use their facilities.[107]

Conclusions

Despite coastal changes and the nature of the difficulties of estimating the roles and variety of harbours in antiquity, wider regional analyses, combining archaeological, epigraphic and historical evidence open up discussions on the nature of coastal economies. The Tyrrhenian coast saw the gradual development of artificial ports and infrastructures, which in turn provide us with information both on the vibrancy of coastal traffic and on the resulting port hierarchies. The roles of the largest ports at Portus and Puteoli, assuming both an important inter-provincial role for large shipments and a local role for the development of small business, can be identified archaeologically and epigraphically, but historically they have also obscured smaller ports, whose role as a local hub is more difficult to show, as the evidence is often scarce or less well-known. It is equally to be suspected that the theoretical divides over the nature of the economy between primitivists and modernists have also left an open gap on the uncomfortable issue of small- and medium-sized organised trade and coastal systems. Surprisingly, measurements of some private harbours can reveal that in some cases they were larger than ports involved in long-distance trade such as Cosa. Medium-sized ports such as Minturnae often played an intermediary role between the smaller, local ports and the major *entrepôts*, though they could also have their own long-distance connections, while the very large new harbours, such as Anzio and Civitavecchia, even though imperial projects close to imperial estates, should be not be understood merely as specific imperial requests or whims, but as investments in order to boost the local economy and satellite harbours of a developing maritime façade.

There are, of course, several complications and limitations when measuring harbour sizes as a means of discussing the economic role of a port, as it is not at all a flawless dataset; on the contrary it is one which has to be used cautiously. This however, applies to any other approach using archaeological material. As already stated, estimating traffic based on harbour sizes works best when we are dealing with artificial harbours. Bays and natural harbours will be much more difficult to estimate—smaller bays clearly associated with a particular site or villa, such as the bay at Gianola, can be taken into account to a certain degree, but larger and more complex natural landscapes will be much more difficult to assess. This picture is also further complicated by the destruction or obstruction of ancient harbour facilities. The facilities at Civitavecchia were renovated in the 1970s, when the ancient structures were covered over with concrete as part of the renovation works. In this case, we are lucky enough to have good documentary evidence. Not so with the Roman port at Santa Marinella, for example, a port linked to the Via Aurelia, well-protected by its 12 m high promontory and natural semi-circular shape. Renovated by Pope Urban VIII, it was then destroyed as part of a strategic move by Pope Innocent X (AD 1644–1655) in order to prevent it from being used while the papal fleet was in Crete assisting the Venetians in their struggle against the Ottomans.[108] For such ports where we have no estimate of harbour size, we must assess them in alternative ways in order to optimise our understanding of coastal connectivity. It is here that we have to reach into the domain of landscape analysis and documentary surveys of rural areas located close to the coast, as at Santa Marinella or around Torre Astura, which show concentrations of productive satellite estates around the coastal estates and ports in these relatively remote areas. From the resulting survey of visible and not so visible ports of the middle Tyrrhenian coast, it must be said that these ports, of wide-ranging sizes and roles, suggest a multi-level hierarchy and a sophisticated network of trading ports working on various scales which escapes the simplicity of fixed maritime patterns.

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107 Again, see Blackman: 'On reflection, I am impressed with the number of *small* harbours in the ancient world' (Blackman 1988: 8).

108 Biffani 1994: 47.

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