



Something old, something new: Historical perspectives provide lessons for blue growth agendas

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1 Something old, something new: historical perspectives provide
2 lessons for blue growth agendas

3
4 **Running title:** Lessons from history for blue growth

5
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66

67 **Abstract**

68 The concept of 'blue growth', which aims to promote the growth of ocean economies
69 whilst holistically managing marine socio-ecological systems, is emerging within
70 national and international marine policy. The concept is often promoted as being
71 novel, however, we show that, historical analogies exist which can provide insights
72 for contemporary planning and implementation of blue growth. Using a case study
73 approach based on expert knowledge, we identified 20 historical fisheries or
74 aquaculture examples from 13 countries, spanning the last 40–800 years, that we
75 contend embody blue growth concepts. This is the first time, to our knowledge, that
76 blue growth has been investigated across such broad spatial and temporal scales. The
77 past societies managed to balance exploitation with equitable access, ecological
78 integrity, and/or economic growth for varying periods of time. Four main trajectories
79 existed that led to the success or failure of blue growth. Success was linked to
80 equitable rather than open access, innovation, and management that was responsive,
81 holistic, and based on scientific knowledge and monitoring. The inability to achieve
82 or maintain blue growth resulted from failures to address limits to industry growth
83 and/or anticipate the impacts of adverse extrinsic events and drivers (e.g., changes in
84 international markets, war), the prioritisation of short-term gains over long-term
85 sustainability, and loss of supporting systems. Fourteen cross-cutting lessons and 10
86 recommendations were derived that can improve understanding and implementation
87 of blue growth. Despite the contemporary literature broadly supporting our findings,
88 these recommendations are not adequately addressed by agendas seeking to realize
89 blue growth.

90

91

92

93	Keywords
94	
95	Ecosystem services; Environmental history; Fisheries; Historical ecology; Marine
96	policy; Sustainable development.
97	
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123 **Introduction**

124

125 The oceans are and have long been of great value to human societies. Half the global
126 population lives within 200 km of the coast, and, of this, half live within 100 km and <100 m
127 above mean average sea level (IPCC, 2019). Seventeen percent of the animal protein we
128 consume is sourced from our oceans, while nearly 80% of all trade goods are transported by
129 sea (FAO, 2018, United Nations, 2016). Including food and trade, the goods and services
130 provided by the oceans were valued at US \$49.7 trillion per year in 2014, which was
131 approximately two thirds of the global GDP (Costanza et al., 2014). This value, however,
132 excludes many of the important services the oceans provide that are difficult to quantify, such
133 as the production of oxygen and the sequestration of anthropogenically produced CO₂
134 (Stocker, 2015, United Nations, 2015).

135

136 In the process of acquiring benefits and services from the sea, we have significantly impacted
137 ocean systems. Humans are responsible for widespread coastal development, habitat loss
138 (United Nations, 2005), pollution (Frid and Caswell, 2017), overfishing (FAO, 2018) and the
139 collective consequences of climate change (IPCC, 2019). In some cases, our effect on marine
140 ecosystems has reduced their ability to provide the ecosystem goods and services we depend
141 upon, such as food, jobs, oxygen, coastal defences, climate regulation and CO₂ sequestration
142 (Costanza et al., 2014, United Nations, 2016). Some of these outcomes might be remediated,
143 and sustainably managing marine resources may enhance the delivery of goods and services
144 (United Nations, 2005).

145

146 The term ‘blue economy’ originated from discussions around the concept of a ‘green
147 economy’ during the United Nations Conference on Sustainable Development (Rio+20) in
148 2012 (United Nations Environment Programme, 2012). The latter term arose in response to
149 recent economic growth being described as ‘brown’: highly industrial, with high-energy
150 demands, often destructive and unsustainable, and based on inequitable employment. A
151 ‘green economy’ was agreed at Rio+20 that aims to “*improve human wellbeing and social
152 equity, whilst significantly reducing environmental risks and economic uncertainties*” (United
153 Nations Environment Programme, 2011). Subsequently, the United Nations (UN) adopted a
154 resolution comprising 17 sustainable development goals (SDG) (United Nations, 2015). In
155 particular, SDG 14 sought to “*conserve and sustainably use the oceans, seas and marine
156 resources for sustainable development*”, and the targets for achieving it included: conserving

157 and restoring marine and coastal systems, ending perverse subsidies and developing capacity
158 in marine science and technology transfer. The ‘Decade of Ocean Science for Sustainable
159 Development’ UN General Assembly mandate (2017) seeks to support the achievement of
160 SDG 14 from 2021–2030.

161

162 A ‘blue economy’ for the oceans is analogous to a green economy on land: it aspires to
163 achieve economic growth that has low energy demands and carbon emissions, and is
164 sustainable and socially inclusive (United Nations Environment Programme et al., 2012). A
165 blue economy also promotes environmental regulations that are integrated across sectors and
166 regions, sustainable maritime business models, and accessible high and low-skilled labour
167 opportunities (Ecorys, 2012). Globally, the oceans were estimated to have provided 31
168 million jobs and US\$ 1.5 trillion in 2010 (OECD, 2016). Estimates from 2016 indicate that
169 the livelihoods of at least 200 million peoples are linked directly and indirectly to fisheries
170 and aquaculture (FAO, 2018). In Europe, the ocean-related economies support nearly 3.5
171 million jobs and generate an annual turnover of € 566 billion from activities including coastal
172 tourism, transport, oil and gas, fisheries and shipbuilding (EC, 2018). Large shifts in
173 employment between maritime sectors are now occurring within Europe as new industries
174 grow and traditional industries contract (EC, 2018).

175

176 Related to the idea of the ‘blue economy’, the concept of ‘blue growth’ has increased in
177 prevalence in recent years (Mulazzani and Malorgio, 2017). The blue growth concept
178 assumes that we can develop strategies to grow our marine and maritime economies in ways
179 that are more sustainable and equitable in the future (Ecorys, 2012), although what is
180 emphasized and how to achieve it varies among organizations and institutions. The European
181 Commission (EC) describes blue growth as an “*initiative to harness the untapped potential of*
182 *Europe’s oceans, seas and coasts for jobs and growth*” (EC, 2012), with objectives to
183 “*promote smart, sustainable and inclusive growth and employment opportunities in Europe’s*
184 *maritime economy*” (EC, 2017a). The EC approach originally targeted five overall sectors as
185 being central to future blue growth: coastal and maritime tourism, renewable energy,
186 aquaculture, minerals and biotechnology (EC, 2010). This initial approach explicitly
187 excluded capture fisheries, implying that there is little room for growth in these sectors in
188 Europe, but this notion was challenged (e.g., Boonstra et al., 2018). More recently, the
189 European Union (EU) has highlighted the “*potential and importance of all relevant sectors of*

190 *the blue economy*”, and now explicitly includes fisheries and places greater emphasis upon
191 innovative approaches across sectors more broadly (EC, 2014, EU, 2017). Contrastingly, the
192 Food and Agriculture Organization (FAO) of the United Nations sees blue growth as a
193 framework that is locally adaptable, but driven by fundamental principles of balancing
194 sustainable and socioeconomic management (FAO, 2017). In 2013, the FAO launched the
195 *Blue Growth Initiative* (BGI) to facilitate sustainable growth of food production in lower-
196 income nations that now produce ~80% of global seafood (Potts et al., 2016). The stated
197 goals of FAO’s BGI are to “*maximize economic and social benefits while minimizing*
198 *environmental degradation from these sectors*” (FAO, 2017). The concept has also attracted
199 attention from the private sector who might profit from projects that seek to restore and
200 reform marine fisheries production, innovation, and management (Encourage Capital, 2016,
201 EKO Asset Management Partners, 2014).

202

203 In both the EU and FAO agendas, there is an implied and underlying assumption that blue
204 growth is a new way forward for the maritime sector, and that it may be achieved via avenues
205 not previously attempted. In particular, the FAO contrasts its initiative against “business as
206 usual” (FAO, 2017). However, while the potential of proposed future growth sectors, such as
207 biotechnology and renewable energies, largely depend on contemporary technological
208 innovations (OECD, 2016), other sectors have historical precedents for achieving blue
209 growth. For example, maritime sectors such as fisheries and transport have been
210 revolutionized by new technologies many times in the past (e.g., Engelhard, 2008, Garstang,
211 1900, Graham, 1956, Jones, 2018), and efforts at balancing growth with community needs,
212 equity, and resource sustainability have previously succeeded (e.g., Fortibuoni et al., 2014,
213 Kittinger et al., 2011).

214

215 Historical instances of blue growth may offer an important opportunity to learn from the past.
216 The value of history has long been asserted, and is illustrated by a wide and growing
217 literature (e.g. beginning with Pauly 1995 and Jackson et al., 2001) that has provided detailed
218 historical perspectives and data on marine system dynamics, socioecological feedbacks, and
219 marine exploitation and management over time (e. g., Alexander et al., 2017, Eero et al.,
220 2011, Fortibuoni et al., 2017, MacKenzie et al., 2011, Sguotti et al., 2016). Historical
221 perspectives have contributed to, e.g. marine planning and policy formulations (e. g.,
222 Engelhard et al., 2016, McClenachan et al., 2012, Schwerdtner Máñez, 2016, Schwerdtner

223 Máñez et al., 2014), management (e.g., Engelhard et al., 2016; Wortmann et al., 2018, Grisel
224 2019), conservation (Kittinger et al., 2015, Ganiyas et al., 2017, Ojaveer et al., 2018, Buckley
225 et al., 2019), and understanding of human responses to sudden and unexpected environmental
226 change (Alexander et al., 2017). Despite the demonstrable value of historical perspectives for
227 contemporary ocean science, management, and conservation most assessments of blue
228 growth potential rely on 5–10 year monitoring baselines, and discussions on how past
229 successes and failures might inform current blue growth agendas are lacking. We posit that
230 the past holds critical lessons on prior successes and failures from which society might learn
231 how to achieve blue growth in the future. This advice is crucial now because there are limited
232 examples of recent blue growth from which we can learn, and blue growth agendas are
233 presently in the early stages of development.

234

235 While the Anthropocene is unprecedented in many ways, not all of the challenges we face
236 today are unique. For centuries to millennia, human beings have impacted, and managed, the
237 natural world (e.g., Jackson et al., 2001, Hoffmann, 2005, Lotze, 2007, Rick and Erlandson,
238 2008, Lepofsky and Caldwell, 2013, Thurstan et al., 2016), and past societies have been
239 revolutionized by technological changes (e.g. Squires and Vestergaard, 2013) as well as
240 population growth and the mass redistribution of people (Magee and Thompson, 2010, Grisel
241 et al., 2019). They have experienced natural disasters (e.g., epidemics and environmental
242 change), and been globally connected by markets, trade, and culture (e.g. Taylor 2002,
243 Erikson and Bearman 2006, Magee and Thompson 2010). Comparable social and
244 environmental changes are occurring now, often at larger scales, and our history is the only
245 resource from which we may obtain insights on how to address such challenges and learn
246 from past mistakes. A longer-term view is crucial as human influences on the environment
247 accelerate (Ven der Leeuw et al., 2011), and we seek to sustainably exploit the natural world.

248

249 In this paper, we used examples from across disparate historical periods, social-ecological
250 systems, and geographic locations around the world. Focussing on historical fisheries or
251 aquaculture, given our expertise, we first asked if historical examples existed of attempts by
252 people to sustain and/or diversify coastal services, enhance the growth of marine economies,
253 and if they succeeded or failed in balancing objectives we would today recognize as akin to
254 blue growth. Of the historical precedents found, we identified the social, economic and
255 ecological drivers behind historical blue growth success and failure, and the trade-offs that

256 occurred for case studies spanning 40–800 years. We then used these examples to develop
257 lessons and recommendations for planners and policy makers today, and compared outcomes
258 with the current literature and blue growth agendas. Collectively, we go beyond merely
259 demonstrating the historical precedent of blue growth – we use that precedent to provide
260 advice, thereby showing how the past holds insights directly relevant to present-day policy
261 and management.

262

263 **Methods**

264 Our overall process is outlined in Figure 1. Firstly, the overarching criteria included within
265 established blue growth agendas were identified. Subsequently, these criteria were used to
266 guide the selection of historical case studies, and to answer the following three questions:

267

268 **Q1:** Did past management strategies and approaches achieve outcomes that reflect the
269 aspirations of the current blue growth agendas?

270 **Q2:** What, if any, lessons do the examples from the past contain for blue growth
271 agendas today?

272 **Q3:** If found, are historical lessons being actioned within contemporary blue growth
273 agendas?

274

275 ***Determining the overarching criteria common to blue growth agendas***

276 Definitions of blue growth vary between regions and organisations, reflecting differing
277 social, economic or governance priorities (EC, 2017a, Eikeset et al., 2018, FAO, 2017).
278 Moreover, policies for many regions are still under development. Therefore, we used the
279 relatively well-established blue growth agendas of the EU and FAO (EC, 2017a, FAO, 2017)
280 as a framework for this study (Fig. 1). In accordance with their remit, the FAO’s blue growth
281 policies focus more on social issues (e.g. equity, access to resources), small-scale fisheries,
282 rural areas, and economically-developing nations and explicitly includes capture fisheries. In
283 contrast, the EU agenda concentrates more on the economic growth of emerging sectors (e.g.
284 seafloor mining, renewable energy). Despite these differences, the agendas overlap in a
285 number of areas. Firstly, they are both generally concerned with forms of growth (e.g.
286 increases in catch, revenue or other value, jobs) that have minimal negative impacts either
287 environmentally or socially (i.e. the growth is “sustainable”). Secondly, both agendas place

288 significant importance on technology, innovation, and efficiency, and often note these as key
289 to ensuring sustainability. In light of these similarities, we determined the overarching blue
290 growth criteria for use in this study as:

291

292 1. **Achieving growth** of marine economies while minimising the risks of negative
293 environmental impacts that adversely affect sustainability.

294

295 2. **Achieving and maintaining balance** among ocean resource use, equitable access
296 among users, efficiency within the supply chain (e.g., food security, employment), and
297 ecological and environmental well-being (e.g., maintaining or improving biodiversity,
298 and ecosystem functioning).

299

300 3. **Implementing smart solutions**, where human innovation increases efficiency while
301 supporting a balance between sustainable use and economic growth.

302

303 4. **Achieving integration** among regions, sectors and stakeholders, where the activities
304 and impacts of the different maritime sectors are interconnected (including
305 consideration of competing interests) via holistic overarching legislative policy(ies) for
306 which stakeholder consultation is inherent. These policies also drive coordination
307 among stakeholders, nations, and transboundary areas (e.g., planning instruments such
308 as spatial planning, international/inter-sectoral agreements such as blue growth cluster
309 partnerships).

310

311 In the following sections, all references to ‘blue growth’ relate to growth or actions that
312 reflect/result in two or more of the defined criteria above. Any reference to blue growth
313 *agendas* refers to existing policies or organizational strategies being proposed (EC, 2017a,
314 FAO, 2017).

315

316 ***Collation of case studies***

317 Historical case studies were originally elicited from researchers working with the
318 International Council for the Exploration of the Seas (ICES) Working Group on the History of
319 Fish and Fisheries (WGHIST) and the EU-COST Action on Oceans Past Platform (OPP).

320 These two groups consisted of academics, government scientists, and practitioners working in
321 the marine ecology, marine fisheries, historical ecology, archaeology and environmental
322 history disciplines, or a combination of these. Initiating the study with experts in these two
323 groups meant the case studies were limited in geographic scope, hence additional experts
324 outside these groups were approached to expand the global perspective.

325

326 Researchers were asked to provide historical case studies based on their own research or
327 expert knowledge where past management strategies and approaches achieved outcomes that
328 reflected the aspirations of current blue growth agendas, as defined for this study (Q1). To
329 make this distinction, the researcher used their expert opinion to determine whether two or
330 more of the overarching blue growth criteria were met in each case study (Fig. 1). The
331 achievement of the criteria did not have to result from historical policies purposefully aimed
332 at growth, balance etc., but could incidentally result from multiple events and/or policies put
333 in place for reasons unrelated to the criteria we identified. Examples of historical blue growth
334 could, therefore, result from either purposeful or unintended actions, and arise from policies
335 or events that were either intrinsic or extrinsic to the system of interest. Researchers
336 identified their case study by stock, system, and time period, and denoted which blue growth
337 criteria it exemplified. Our case studies primarily focused on historical fisheries or
338 aquaculture for which the historical literature was replete with examples (Fig. 2).

339

340 Expert knowledge is commonly used when empirical or comparable data are scarce (e.g.,
341 Selkoe et al., 2008; Pascoe et al., 2009). Researchers expert in the requested topic may be
342 requested to make judgement calls about the reliability of sources of differing quality or
343 uncertainty, including cases where data are missing, or to interpret non-quantitative or
344 context-dependent data according to their understanding of a particular system (Knol et al.,
345 2010; Dessai et al., 2018). In this study, researchers chose periods and systems for which they
346 were familiar with relevant historical literature, the context and socioecological events
347 surrounding the case studies. Each researcher presented their interpretation of the outcomes
348 that were analogous to blue growth in accordance with the four criteria identified above.
349 Information was requested in a predetermined tabulated format that facilitated comparisons
350 between case studies (Table 1, SOM Table S1) and this included the primary drivers that
351 facilitated or restricted blue growth, backed by historical evidence. Each researcher produced
352 an accompanying descriptive summary and a list of key sources (SOM S1). Due to the
353 context-dependent interpretation of historical sources, which can be biased by the cultural

354 and/or academic background of the researcher, or change over time as new evidence comes to
355 light, the above approach is not as readily reproducible as some published in the natural
356 sciences. However, this approach is in line with established expert elicitation protocols
357 (Selkoe et al., 2008; Pascoe et al., 2009).

358

359 ***Determining cross-cutting Lessons from historical case studies***

360 To determine what, if any, lessons the examples from the past contained for blue growth
361 agendas today (Q2) researchers first provided case study-specific lessons (e.g., social,
362 ecological, political, economic etc.) (Table 1, SOM Table S1). To assess whether these
363 lessons had broad implications, three of the authors identified those that cut across multiple
364 case studies (“Lessons”). These cross-cutting Lessons did not need to apply across every case
365 study, but to increase our confidence in their applicability to blue growth agendas more
366 broadly, Lessons needed to apply to case studies from more than one time period and more
367 than one region and/or fishery.

368

369 ***Developing recommendations from cross-cutting Lessons***

370 We used the 14 cross-cutting Lessons to construct a list of recommendations (actionable
371 statements that reflected the sum of the cross-cutting Lessons, hereafter “Recommendations”)
372 that were deemed relevant for blue growth agendas today. In some cases, the Lessons were
373 relevant to, and were thus incorporated into, multiple Recommendations. To assess whether
374 the cross-cutting historical Lessons were being actioned within blue growth agendas (Q3) we
375 evaluated whether similar statements/subject matter were, or were not, already included in the
376 established high level EU and FAO blue growth agenda documentation (Fig. 1) (EC, 2012,
377 EC, 2014, EC, 2017a, EC, 2018, FAO, 2017), and so whether these Recommendations did or
378 did not constitute new knowledge.

379

380 **Results**

381 ***Q1: Did past management strategies and approaches achieve outcomes that reflect the*** 382 ***aspirations of the current blue growth agendas?***

383 We obtained 20 historical case studies from thirteen countries. These focused on capture
384 fisheries (14 case studies) or aquaculture (6 case studies), and all exemplified at least two of
12

385 the four blue growth criteria identified from the EU and FAO documents (Table 1, Table S1
386 SOM 1). Nine case studies focused upon growth in the context of a single species being
387 fished or cultured, while 11 related to multi-species fisheries or aquaculture. Examples of
388 blue growth were observed across multiple locations and cultures during many past periods,
389 with case studies spanning 40 to 700 years duration (median = 80 years; Fig. 2).

390

391 Four common blue growth trajectories were identified across the case studies (Fig. 3). Three
392 trajectories exhibited some form of unbalanced growth, where economic growth was
393 prioritized over social equity and/or sustainability, whereas the fourth balanced growth with
394 social equity and ecological sustainability. In five case studies (1, 3, 7, 8 and 13), growth was
395 observed initially, but was not maintained as economic investment occurred at the expense of
396 social equity and/or ecological sustainability (unbalanced growth, Fig. 3a). In five case
397 studies (5, 6, 9, 18 and 20), the same pattern occurred but the eventual contraction of growth
398 was delayed due to innovation (delayed unbalanced growth, Fig. 3b). In six case studies (4,
399 10, 11, 12, 14 and 16), an initial period of growth was followed by stasis or contraction after
400 which growth (or at least the potential for it in the future) was re-established due to
401 improvements in ecological sustainability and/or social equity (recovery, Fig. 3c). In four
402 case studies (2, 15, 17 and 19), the factors contributing to growth were largely balanced,
403 hence growth was observed throughout the case study period (balanced growth, Fig. 3d). In
404 these cases, growth might be punctuated by extrinsic and/or intrinsic political and/or
405 economic events, or be bolstered by innovations and/or new markets, but factors contributing
406 to growth remained largely balanced and thus growth continued.

407

408 ***Q2: What, if any, lessons do the examples from the past contain for blue growth agendas***
409 ***today?***

410 We identified a total of 118 case study specific lessons, with each case study providing
411 between 2 and 7 specific lessons (for worked example, see Fig. 4). From these, 14 cross-
412 cutting Lessons were identified that were common to multiple case studies (Table 2). Each of
413 these Lessons is described below, with cross reference to the relevant case studies denoted in
414 parentheses. Lesson 1 focused on the different scales across which blue growth can occur;
415 Lessons 2–5 considered the factors that may undermine, inhibit or complicate growth; Lesson
416 6 described what is required to translate innovation into growth; Lessons 7–10 described the

417 relationships between stakeholders and blue growth and the challenges to these relationships;
418 Lesson 11 considered issues of equitability; Lessons 12–13 illustrated some of the
419 management requirements for the achievement of blue growth. Finally, Lesson 14 portrayed
420 the inevitable trade-offs inherent to blue growth, particularly in degraded ecosystems.

421

422 ***Lesson 1.*** *To determine whether blue growth has occurred, outcomes should be assessed over*
423 *a range of scales.*

424 From the case studies, we observed blue growth trajectories and outcomes varying across
425 temporal and spatial scales. Firstly, while it could be realised over long periods, achieving
426 blue growth in the short term did not necessarily mean it would be maintained. Some case
427 studies did demonstrate prolonged periods, even hundreds of years (e.g., case studies 3, 10,
428 17) over which blue growth appeared to be sustained, and in others blue growth was
429 sometimes re-established after being lost. For example, in Hawai‘i, blue growth was arguably
430 maintained for many centuries (10a), but overexploitation accelerated following colonization
431 by Europeans in the 18th century (10b–d). More recently, blue growth is slowly being re-
432 established through the increased protection and regulation of marine habitats and fisheries
433 (10e). However, in other case studies, blue growth was maintained for a shorter period of
434 time before being undermined, after which little or no recovery was evident (e.g., 5–7, 13).

435

436 Secondly, we found that spatial and economic scales were also important in determining
437 whether blue growth was realised. In Ireland’s Galway Bay (1), local blue growth in mixed
438 capture fisheries halted when management shifted from a local to a regional and national
439 focus. In New England (8), the loss of blue growth was precipitated when small-scale fishers
440 were out-competed by larger commercial fishers driven by the demands of a larger, regional
441 market, during the late-19th century. The importance of acknowledging the impacts of spatial
442 and economic scales are echoed in other case studies, including those in the Lagoon of
443 Venice (3) and in the Adriatic Sea (5). These examples suggest that, although blue growth is
444 often described as a notable increase or scaling up of production, such growth at large spatial
445 or economic scales can inhibit blue growth at smaller or local scales.

446

447 ***Lesson 2.*** *The prioritisation of short-term gains can lead to long-term losses in blue growth.*

448 While dovetailing Lesson 1, we found this Lesson significant enough to delineate. The case
449 studies demonstrated that the prioritization of short-term gains could have had long-term
450 consequences that ultimately destabilized blue growth. Marine use in Galway Bay (1)
451 achieved blue growth in the early half of the 19th century, but larger-scale concerns (i.e.,
452 feeding a growing population) aided by the development of novel technologies prioritized
453 swift economic growth over the sustainability concerns of local fishermen and, in time,
454 resulted in overexploitation at local and ultimately regional scales. Management in the
455 Adriatic (5, 6), Venice Lagoon (3), and Sweden (9) similarly lost elements of blue growth
456 when they adopted a focus on short-term gains, prioritizing the ambitions of certain
457 stakeholders and markets over longer-term ecological sustainability and social equity. In
458 contrast, regulations in the Lagoon of Venice prior to the 19th century (3) maintained
459 objectives that favoured long-term sustainability, with associated societal benefits, that
460 spanned centuries (Fig. 4). This was also the case in Hawai‘i before European colonization
461 (10a). In both Venice and Hawai‘i, later shifts to emphasize shorter-term gains degraded
462 fisheries resources, as well as traditional rules of access (Fig. 4). These case studies show the
463 need to consider both the immediate and long-lasting costs and benefits of new management
464 regimes or novel technologies for blue growth.

465

466 ***Lesson 3. Failure to understand and address the limits to industry growth may have***
467 ***ecological, social and economic consequences, including system collapse.***

468 Our historical examples demonstrated that, where economic concerns, markets, or some
469 stakeholder demands are prioritised over the ecological and environmental limits to the
470 expansion of industry and/or human use, severe ecological, social and/or economic
471 consequences can result. For example, overexploitation and other stressors driven by
472 technological advancement and economic priorities resulted in the sequential collapse of
473 oyster (*Crassostrea virginica*, Ostreidae) fisheries in the United States (16). Similarly,
474 uncontrolled industry growth in fisheries of the Irish (1), Adriatic (6), North (12) and Baltic
475 (13) seas led to the collapse of stocks and/or sub-populations, consequently limiting blue
476 growth.

477

478 ***Lesson 4. The nature of blue growth can be unpredictable, nonlinear, and attributed to***
479 ***multiple factors.***

480 Several case studies demonstrated that blue growth does not necessarily proceed in a linear
481 fashion (i.e., via the stepwise accumulation of knowledge and skills, or in line with
482 population growth). Instead, opportunities can be non-linear and originate unexpectedly. The
483 most common example across our case studies was the facilitation of rapid periods of
484 economic growth by technological or scientific innovation (1, 4–6, 8–10, 12–17, 18, 20),
485 although such innovations were often accompanied by unsustainable practices or a lack of
486 regulation, leading to a halting or reduction in the rate of blue growth (1, 6, 8–9, 13–14, 16).
487 Sudden and often unexpected blue growth in some case studies was also precipitated by
488 product development, new markets, and/or developments in scientific understanding. For
489 example, research and technological innovations coincided with growing demand, leading to
490 rapid increases in production of nori (genus *Porphyra*, Bangiaceae) in Japan post-World War
491 II (17). In Columbia, scientific innovation produced shrimp larvae *Penaeus* sp. (Penaeoidea)
492 resistant to the white spot virus, which – up until the advent of unfavourable economic
493 conditions – enabled extremely high yields to be attained (20). In South Australia, the
494 production of a once marginal Southern Bluefin tuna (*Thunnus maccoyii*, Scombridae)
495 industry grew and became mainstream due to individuals' willingness to speculatively invest
496 and undertake product development (4). Changing industry dynamics can also present
497 opportunities for blue growth: technological innovation and investment in aquaculture in the
498 Adriatic was aligned with and partially stimulated by declining wild fisheries production in
499 the region (5).

500

501 ***Lesson 5. Drivers and events occurring outside the immediate system can critically impact***
502 ***the achievement and maintenance of blue growth.***

503 Events and factors that are external to a maritime sector, in this case fisheries and
504 aquaculture, can impact whether blue growth criteria are met or maintained. These external
505 drivers and events include international or regional shifts in market demand and the
506 corresponding industrial effort (4, 7), growth (8) or decline (5) of other fisheries, as well as
507 ecosystem or environmental changes (13), periods of political change (3, 8, 10a–b), war (17),
508 epidemics (10b), and international or regional policies or management (4). In Hawai'i (10b),
509 a sustainable ocean economy had been maintained for centuries, but was undermined with the
510 advent of colonist rule, and later market pressures and associated shifts in modes of
511 production. In the Lagoon of Venice (3), political instabilities in the wider region contributed
512 to the loss of social structures and management regulations that had previously maintained

513 blue growth (Fig. 4). Blue growth in Hong Kong oysters (*Crassostrea hongkongensis*,
514 Ostreidae) (18) was undermined by numerous extrinsic forces, including natural disaster,
515 pollution, rapid coastal development, disease, and shifts towards alternative employment for
516 the younger work force, namely the financial trading and technology sectors. The Hong Kong
517 case study illustrates the importance of culture and perception for blue growth and its
518 success; whereby the above factors precipitated a cultural shift, from oyster aquaculture as a
519 means of economic growth, towards its value primarily being as a heritage industry. These
520 examples show how such changes can inhibit blue growth through reduced demand,
521 disruption to overseas trade, or via impacts on the workforce. Parallel expansion in non-
522 fishery sectors, such as agriculture (7, 10b) and tourism (10d) can also inhibit blue growth, as
523 can the diversion of local labour (10b, 17) to fisheries in other regions or nations, or to other
524 industries.

525

526 Extrinsic drivers can also have positive outcomes for blue growth. The growth of sustainable
527 seaweed culture industries (15, 17) was facilitated by regional and global demand for
528 seaweeds as food and for alginate products. Environmental concerns and an increasing
529 awareness of conservation challenges aided cultural and social shifts and management
530 enforcement, leading to greater sustainability in the recreational fisheries of Queensland,
531 Australia (2). International overexploitation of Southern Bluefin tuna, together with industry
532 innovation, precipitated the growth of an aquaculture industry there as well (4). Runoff of
533 excess agricultural fertilisers in Japan facilitated nori culture, allowing it to expand into
534 offshore areas, increasing production (17). In some cases, related ecosystem services may
535 confer additional benefits, for instance oyster reef restoration in the United States not only
536 serves to increase oyster production, but also related wild finfish populations by providing
537 habitat for juveniles, and contributing to improvements in local water quality (16).

538

539 **Lesson 6.** *Supporting systems may be important for translating innovation into blue growth.*

540 Support that extends beyond direct management or policy may also be valuable for blue
541 growth, such as related technological developments and research, or existing or developing
542 markets and infrastructure. For instance, the early growth of the Southern Bluefin tuna
543 fishery (prior to ranching) in South Australia was supported by product innovation (i.e.,
544 canning) (4). In Japan, government support for innovation, and the expansion of growers'
545 unions provided infrastructure (culturing and drying facilities) and policies to help supply

546 demand and increase production of nori (17). The success of oyster restoration projects and
547 knowledge gained from this process in North America has been leveraged for restoration
548 projects and subsequent blue growth opportunities in Australia and Europe (16). Finally,
549 careful management and monitoring of the introduced Kamchatka king crab (*Paralithodes*
550 *camtschaticus*, Lithodoidea) by both Norway and Russia, combined with favourable climate
551 conditions, has thus far facilitated growth of a productive industry benefitting local fishing
552 communities in Norway and commercial industry in Russia. This case study provides a rare
553 example of blue growth based on invasive species (19).

554

555 **Lesson 7.** *Stakeholders hold diverse perspectives and socio-ecological knowledge, and this*
556 *can be leveraged to support the achievement of blue growth.*

557 Our case studies indicate that both respect for stakeholder knowledge and encouraging their
558 engagement can be valuable for achieving and maintaining blue growth. In several historical
559 case studies (1, 3, 6–7), a shift away from community-based or community-managed fisheries
560 and overlooking the concerns of local or traditional resource users played a role in weakening
561 blue growth. For example, the lack of engagement with Aboriginal perspectives and
562 knowledge may have contributed to collapse in the dugong (*Dugon dugong*, Dugongidae)
563 fisheries in South Queensland (7). In Hong Kong (18), ongoing local pride in oyster
564 cultivation does not hold sufficient societal value to attract new fishers and thus encourage
565 growth. In others, stakeholder engagement was key to the promotion of blue growth, e.g. the
566 Norwegian seaweed sector (15) benefitted from stakeholder engagement coupled with strong
567 management, research, and investment in monitoring.

568

569 Our case studies also revealed that stakeholders and resource users hold a wide variety of
570 perspectives and values beyond maximizing harvesting, extraction, or profit. For example, in
571 Queensland's recreational fisheries (2), cultural and social incentives were critical in the
572 shifts towards more sustainable exploitation strategies. Similarly, in the past, stakeholders
573 within a number of fisheries have been aware of the need to limit harvesting for long-term
574 sustainability, and vocal in opposing what they considered to be overly destructive gear (1, 3,
575 10a).

576

577 **Lesson 8.** *Environmental stewardship can support blue growth and may be facilitated by*
578 *cultural and social attributes as well as economic incentives.*

579 Our examples from the past show that environmental stewardship can support blue growth.
580 Providing economic incentives is one way of encouraging people to shift from consumptive
581 to conservationist behaviours, but our case studies suggest additional ways forward.
582 Hawaiian communities had a long legacy of environmental stewardship that helped maintain
583 many sustainable reef fisheries prior to colonialism (10a), indicating the importance of
584 existing social systems and cultural norms. In Queensland, Australia (2), shifts in cultural
585 norms were aligned with changes in the management of recreational fisheries, which
586 collectively led to increased environmental stewardship and the likelihood of community
587 members recognising the need for responsible fishing practices to maintain stocks. In the
588 Lagoon of Venice (3), long-term sustainability and local needs were valued by society as a
589 whole, and together with co-management structures, resulted in centuries of sustainable use
590 that supported societal well-being. Contrastingly, in Hong Kong changes in cultural values
591 and motivations undermined the long-term sustainability of oyster aquaculture (18), which
592 had previously been maintained for centuries. In these case studies, environmental
593 stewardship was supported by cultural and social structures, not simply economic incentives
594 (Fig. 4).

595

596 **Lesson 9.** *The benefits of blue growth may be unequal or incompatible across stakeholder*
597 *groups, which can create conflict or limit growth if one group's needs are prioritised over*
598 *others.*

599 In the Swedish commercial fisheries (9), a focus on the growth of industrial fisheries
600 encouraged the prioritization of economic gains over other goals, including equitable access.
601 Consequently, it became too difficult for small-scale fisheries to compete, and they exited the
602 fishery. The overcapitalization of the fleet driven by particular stakeholders also ultimately
603 aided overexploitation and the erosion of blue growth that existed in the early 20th century.
604 Dugong fisheries in Southern Queensland (7) had the potential to embrace blue growth via
605 collaboration across resource user groups, specifically with local indigenous communities.
606 However, these communities were quickly excluded from the fishery (both in terms of
607 economic gains and access to the resource), which resulted in a loss of equity and indigenous
608 ecological knowledge. In the Baltic Sea (11), grey seal (*Halichoerus grypus*, Phocidae)

609 population recovery has increased opportunities for eco-based tourism, but also seal-fisher
610 conflict. Conversely, the growth in commercial harvesting of wild seaweed in Norway was
611 facilitated by a lack of inter-sectoral conflict, supported by strong management regulations
612 (15). Collectively, these case studies highlight the significance of understanding user groups
613 and their needs, the potential importance of outside regulations to maintain equity, and,
614 ultimately, anticipating that actions may not benefit all groups equally or simultaneously.
615

616 **Lesson 10.** *Equitable access does not always correspond with open access nor produce the*
617 *same outcomes.*

618 Several of the historical examples demonstrated that equitable access was not the same as
619 open access. In these case studies, economic gains resulting from shifts to open access often
620 occurred at the expense of long-term sustainability and stakeholder equity. For example, the
621 dependence of local communities on the Lagoon of Venice (3) resulted in strict regulation of
622 the fishery and markets, and this was key to centuries of sustainable use akin to what would
623 be blue growth today. When de-regulation later led to open access and the loss of these
624 regulatory structures, overexploitation and destructive fishing practices undermined blue
625 growth there (Fig. 4). In Sweden's lobster (*Homarus Gammarus*, Nephropidae) fishery
626 during the 19th and early 20th centuries (14), fishing rights were often assigned to local
627 fishers. Together with seasonal and minimum size regulations, this restricted access helped to
628 maintain the sustainability of the fishery. As with Venice, when access was expanded after
629 the 1950s, fisher numbers grew and lobster populations declined due to unsustainable levels
630 of exploitation.

631

632 Our case studies further caution that groups with less representation in stakeholder
633 engagement frameworks and political discourse may be particularly disadvantaged under
634 open access. For example, Galway fishers' concerns about the economic and ecological
635 impacts of bottom trawling on their local ecosystem (1) were initially dismissed as 'foolish
636 prejudices' by the regulating authorities, not least to encourage the growth of highly
637 capitalized trawling companies (Commissioners of Fisheries, 1854, Thurstan et al., 2014).
638 Similar dynamics between wealthy users and political power were at play in the Swedish
639 fisheries where small-scale fishers were ultimately outcompeted (9). Substantial ecological
640 knowledge and traditional fishing practices were transferred from Aboriginal Australians to
641 early Europeans (7), yet ingrained racial prejudices resulted in Aboriginal contributions to
20

642 these early fisheries being quickly minimised and erased from societal memory (Kerkhove,
643 2013). In all these cases, groups with less political influence were the most disadvantaged
644 under open access, thus undermining equity and therefore blue growth.

645

646 **Lesson 11.** *Management based on scientific knowledge and supported by ongoing monitoring*
647 *may be key for blue growth.*

648 Scientific understanding and continued monitoring were key to past blue growth. In the
649 Southern Queensland dugong fisheries (7), the potential for blue growth was in part
650 diminished by a lack of scientific understanding about the stock. Similarly, a lack of
651 ecological knowledge meant that autumn and spring spawning herring (*Clupea harengus*,
652 Clupeidae), two distinct stocks, were inappropriately managed together in the Gulf of Riga
653 (13). As the herring stock did not show a considerable overall change, the overexploitation of
654 the autumn spawning stock was not recognised until after biomass had severely decreased.
655 Swedish lobster fisheries (14) demonstrate the importance of monitoring recreational
656 fisheries, and Russian and Norwegian crab fisheries demonstrated the possible opportunities
657 associated with introduced fisheries species (19). In contrast, in both the Norwegian
658 *Laminaria hyperborea* and Japanese *Porphyra* spp. seaweed fisheries, blue growth was
659 bolstered by ecological knowledge and investment in scientific research and monitoring (15,
660 17). In Columbia, marine shrimp aquaculture was enhanced by scientific investigations into
661 and the subsequent production of virus-tolerant shrimp larvae (20), while an appreciation of
662 the connections between habitats and ecosystem services supported blue growth through the
663 restoration of oyster habitats in the United States (16).

664

665 Our case studies show the significance of scientific knowledge and monitoring for
666 maintaining blue growth in the face of technological change in particular. Investments in
667 ecological knowledge helped increase product quality and farming efficiency within the
668 Southern Bluefin Tuna (*Thunnus maccoyii*, Scombridae) aquaculture industry in South
669 Australia (4). Aligned with strong and consistent management, this allowed for sustainable
670 resource use alongside technological advancement and economic growth, whereas a lack of
671 knowledge corresponded with overexploitation. These case studies indicate that scientific
672 knowledge and monitoring may be key to understanding how innovation can facilitate blue
673 growth strategies while avoiding overexploitation (Lessons 2 and 3). This is especially

674 significant given the potential for unchecked advancement to exceed the natural limits of a
675 system (e.g. 9; Lesson 3).

676

677 **Lesson 12.** *For blue growth to be maintained, policy and management should be flexible,*
678 *responsive, and adopt a whole-system view, including across multiple jurisdictions when*
679 *required.*

680 A whole-system view (including the human component, Lessons 3 and 8) may be important
681 for maintaining blue growth over the long-term, and management should strive to be
682 responsive and flexible to change. For example, traditional management in Hawai'i
683 acknowledged the linkages between different systems (e.g., between ecological and social),
684 which enabled long-term blue growth (10a). Taking into account the potential for sudden and
685 unexpected change (Lesson 6) and the significance of extrinsic factors (Lesson 4), it is also
686 important that management is able to respond and adapt to changes at a systems level.
687 Finally, in cases where fish populations straddled multiple jurisdictions, management and
688 policy must go beyond the prescribed jurisdictional boundaries. Transnational oversight has
689 proven to be effective at sustainably managing some stocks (4, 12, 19), although multi-
690 jurisdictional management can be challenging and it can take time for its effectiveness to be
691 demonstrated (12).

692

693 **Lesson 13.** *Regulations (whether top-down or bottom-up) can facilitate and maintain blue*
694 *growth, but adequate enforcement and community buy-in can be critical.*

695 Our case studies suggest that the regulations for resource use can help to maintain stock
696 biomass and facilitate aspects of blue growth, especially over the longer-term. How
697 regulations were decided upon, who enforced them, and how successful the various strategies
698 were differed between case studies. In those where regulations played a role in helping
699 achieve blue growth, we found adequate enforcement and community buy-in also occurred.
700 For example, in the Lagoon of Venice (3), strong, top-down regulations promoted sustainable
701 exploitation and maintained ecosystem services (e.g., fish habitat), and ensured equitable
702 access to markets as well as fishery resources. Critically, these regulations were also strictly
703 enforced. In case studies where this was not the case, regulations sometimes fell short of
704 ensuring long-term blue growth (e.g., 6, 7, 12). In other case studies, fisheries community
705 buy-in played an equally important role in ensuring the success of regulations. Such

706 community engagement was facilitated by adherence to long-standing cultural or social
707 norms and controls (e.g., on the consumption of certain reef fauna in Hawai‘i, 10a), emerging
708 cultural norms (e.g., increased stewardship in recreational fisheries in Australia, 2), or
709 realized via shared ownership, i.e. co-management between state and fishers in the Lagoon of
710 Venice (3) and/or local control of the resource (e.g., control of Galway Bay’s resources by
711 local fishermen in the pre-trawling era, 1).

712

713 ***Lesson 14. Growth, ecological sustainability, and social equity may not be achieved***
714 *simultaneously; trade-offs may be necessary.*

715 Our case studies caution that aspects of blue growth may not always be mutually compatible,
716 indicating the potential for trade-offs among aims under blue growth agendas and the need
717 for clear consideration and prioritization of goals. For example, a common theme within the
718 historical case studies was the loss of small-scale fisheries due to the emergence and
719 dominance of larger-scale fisheries (1, 8, 9, 10b–d, 12). While these fisheries can promote
720 economic growth and may more rapidly engage advancing technology, this often came at the
721 expense of other blue growth criteria, such as social equity and ecological sustainability
722 (Lessons 1–2). Lesson 10 also speaks to the potential for trade-offs between resource user
723 needs, access, and well-being. Taken together, the case studies suggest that not all needs or
724 blue growth criteria may be met simultaneously.

725

726 The North Sea fisheries demonstrated other possible trade-offs, particularly within the
727 context of recovering degraded ecosystems (12). During the 1970s, it was recognized that
728 weak management and over-capacity in the fleet had led to the deterioration of North Sea fish
729 stocks. The enactment of the Common Fisheries Policy after 1983 introduced restrictions in
730 fishing effort and landings, with the aim of enabling the recovery of depleted stocks. While
731 the status of North Sea fish stocks did indeed shift from deterioration to recovery during the
732 2000s, trade-offs included the loss of jobs and of some traditional fishing communities and
733 cultures (also in 9).

734

735 ***Q3: If found, are historical lessons being actioned within blue growth agendas?***

736 Many of the cross-cutting historical Lessons aligned and were readily organized into
737 actionable statements, i.e. the Recommendations. Ten Recommendations (A–J) were

738 produced from the 14 cross-cutting Lessons (Table 3), with most Lessons applying to more
739 than one Recommendation. Four of the Recommendations (A–D) applied to the planning
740 process of blue growth, four (E–H) were relevant to management that supports the
741 implementation of blue growth, while two (I–J) were applicable to blue growth agendas after
742 ratification (Table 3). Recommendations highlighted the significance of considering and
743 balancing short- and long-term outcomes, and the needs of local and regional stakeholders
744 during the planning process (Recommendations A–B). Our case studies also suggest that
745 stakeholders hold a multitude of diverse values that have implications for blue growth (e.g.
746 Lesson 7). On the one hand, it may be challenging to address all user group needs, but on the
747 other, variation in stakeholder values indicates that some or many of these values may align
748 with blue growth principles and goals. In either case, engaging stakeholders in decision-
749 making can fortify blue growth (B), especially when it illuminates social and cultural values
750 that can be used to align regulations, technological advancement, and economic growth (C).
751 Yet trade-offs among groups and goals can make it challenging to achieve all blue growth
752 criteria simultaneously, and it will be crucial to have a plan for assessing those trade-offs (D).
753 Collectively, recognition of trade-offs and diversity amongst stakeholders is needed for
754 management to effectively support blue growth and equity (E). Finally, and for all of these
755 reasons, active, enforceable, adaptable and holistic management (F–H), supported by
756 monitoring and scientific inquiry and a long-term perspective is necessary for blue growth to
757 be sustained (I–J).

758

759 All of the Recommendations were partially addressed in the EU blue growth agendas (SOM
760 2, Table 3), and five were partially addressed in both EU and FAO agendas. Only one
761 Recommendation was comprehensively represented in both the EU and the FAO blue growth
762 agendas (B – identifying and engaging stakeholders in the decision-making process) (FAO,
763 2017, EC, 2012), with one other included in the FAO agenda alone (E – focus on facilitating
764 equitable access). Three Recommendations (A – defining scale, D – planning for trade-offs,
765 and J – ensure continuous monitoring) were not included in the FAO high-level blue growth
766 documentation (Table 3).

767

768 **Discussion**

769 Prior resource exploitation and the sustainability challenges of a rapidly growing global
770 population are already constraining our ability to derive benefits and services from ocean

771 resources (Costanza et al., 2014, Hirons et al., 2016, OECD, 2016, Stocker, 2015, United
772 Nations, 2016, WWF, 2015). Today, blue growth is discussed as a novel concept and
773 approach for sustainable ocean governance (OECD, 2016) that will maintain and perhaps
774 expand these benefits in the future (e. g., EC, 2017a, FAO, 2017). Our synthesis
775 contextualises contemporary conversations on blue growth and provides novel insights for its
776 advancement in several ways. Firstly, the range of case studies, covering disparate social-
777 ecological systems, time periods, and locations (Fig. 2), demonstrates that whilst the term
778 ‘blue growth’ is new its achievement and aims are not. What we today refer to as blue growth
779 has previously spanned decades to centuries in some cases, with earlier societies embracing
780 new technology and balancing resource exploitation with equitable access, ecological
781 integrity, and economic growth. These examples show that what is considered blue growth
782 today has been inherent in people’s use and engagement with the sea for centuries, and
783 suggest there are significant lessons to be learned from history. Secondly, the perspectives
784 and insights from the 20 case studies and 13 different countries, considered in this study,
785 show how blue growth can be achieved and, equally critically, be maintained. We determined
786 four general trajectories of blue growth (Fig. 3), and identified 14 significant Lessons and 10
787 Recommendations that are broadly relevant for today’s blue growth agendas.

788

789 One critical outcome of our work is that the Recommendations we resolved are not
790 comprehensively addressed in either the EU or FAO blue growth agendas (Table 3). These
791 are the most well-established international blue growth agendas presently available.
792 However, there is real need for such advice: because blue growth programs are still in their
793 infancy, and examples of how blue growth might operate in practice and what successful
794 outcomes may look like are very limited (Lasner and Hamm, 2014, Pinto et al., 2015, Potts et
795 al., 2016, She et al., 2016, Zhao et al., 2013) and do not refer to history. The insights from the
796 present study therefore can start to address these gaps in our knowledge and give direction to
797 future work.

798

799 ***The opportunities and challenges for blue growth***

800 Blue growth agendas aim to diversify marine resource use in countries with medium-to high-
801 income economies, and fully or over-exploited resources (EC, 2018), but also represent a
802 basis for furthering sustainable resource use in lower-income economies (FAO, 2017).

803 Technological innovation is expected to play a crucial role in the development and

804 management of future blue growth (OECD, 2016), and this could include the expansion of
805 the wild capture fisheries that are presently overfished/fully exploited (e.g., FAO, 2018). Our
806 case studies demonstrated that blue growth *can* occur even when a resource is fully exploited
807 or the wider ecosystem is degraded, either via product development, added value, and/or
808 innovation (if supporting systems exist). In these ways, additional novel revenue streams may
809 be possible without undermining the longer-term provisioning of those species or stocks that
810 are already fully or overexploited (e.g. Condie et al., 2014). These observations support the
811 estimates of Costello et al., (2016), who suggested that fisheries reform could increase global
812 capture fisheries production by 16 million metric tons and \$53 billion annually (see also
813 Hilborn and Costello, 2018). Others propose that value can be added to existing capture
814 fisheries through certification, more efficient use of resources, and specialization (Boonstra et
815 al., 2018, Lasner and Hamm, 2014, Potts et al., 2016). Further, novel revenue streams such as
816 the ‘restoration economy’ can create jobs, restore valuable coastal habitats and the associated
817 ecosystem services (Abelson et al., 2016, Conathan et al., 2014). Therefore, despite the
818 degraded or fully exploited state of some marine ecosystems, opportunities for blue growth in
819 the fisheries and aquaculture sectors certainly exist. However, the present study also cautions
820 that, to achieve blue growth, such opportunities need to be assessed within the context of past
821 and present stressors, socio-ecological factors, and trade-offs.

822

823 Insights from across our historical case studies also suggest there are critical challenges for
824 today’s blue growth agendas. Firstly, blue growth can be both achieved and lost over time,
825 and different trajectories may be observed depending on a range of factors (Fig. 3). What
826 might be deemed blue growth over the short-term (years to decades) may not be sustainable
827 for longer periods (Lesson 1), or it may be undermined by decisions that prioritise short-term
828 goals or benefits (Lesson 2). In the majority of our case studies, blue growth was sustained
829 for limited periods only. For instance, in 40% of case studies, blue growth occurred for less
830 than four decades, and in a further 20% of cases growth was maintained for five or six
831 decades and was then undermined because of a failure to understand and address limits to
832 industry growth (Lesson 3). Thus, we caution against assuming that, once reached, blue
833 growth will be maintained. Moreover, our results indicate failure is usually followed by slow
834 recovery that can undermine future blue growth; for example, in these cases between 50–400
835 years had elapsed before wild fish and shellfish populations attained comparable state to
836 those preceding exploitation.

837

838 Secondly, our case studies highlight that perspectives on whether (or not) blue growth is
839 achieved are highly dependent on the scale of observation (Lesson 1). Success in one location
840 or for one group may be detrimental to growth in another; blue growth nationally may come
841 at the expense of achieving blue growth locally. Thirdly, our findings illustrated that the
842 achievement, and sometimes failure, of blue growth historically was often at least partly
843 attributable to natural and socioeconomic drivers that were extrinsic to the system of concern
844 (Lesson 5). In particular, market demand, political instability, activity in other sectors and
845 environmental change were important in a range of case studies. Contemporary blue growth
846 agendas should therefore try to: identify the connections between global markets, understand
847 geopolitical dynamics and other socio-ecological linkages (e. g., Burgess et al., 2018, Lasner
848 and Hamm, 2014, OECD, 2016) so that their effects can be anticipated and adjustments made
849 if required.

850

851 *Alignment with current research and blue growth agendas*

852 Some results from the historic case studies are unsurprising given that ecosystems are not
853 static, they transcend jurisdictional boundaries, and are inherently variable through both
854 space and time (Kritzer and Sale, 2004, Lees et al., 2006, Levins, 1970), as are socio-
855 ecological outcomes and management approaches (e. g. Jackson et al., 2001, Kittinger et al.,
856 2015, Pandolfi et al., 2003, Pinto et al., 2015, Rick and Erlandson, 2008, Waycott et al.,
857 2009). Similarly, in the historical case studies technological change followed nonlinear
858 and/or unexpected trajectories rather than gradual and incremental transformation (Lesson 4)
859 (e. g., as proposed by Squires and Vestergaard, 2013). The temporal and spatial scale
860 (Steneck and Wilson, 2010) as well as the interconnections between systems were important
861 in our historical case studies (Lessons 4-6) and present clear challenges for management
862 (Brown et al., 2001, Fulton et al., 2011, Goodsir et al., 2015). Our findings parallel current
863 debates surrounding the achievement of the Sustainable Development Goals (SDGs): the
864 SDGs may be synergistic, but will probably require trade-offs that vary regionally and/or case
865 by case (Nilsson et al., 2016).

866

867 Principles from resilience thinking (Biggs et al., 2015) were echoed in our findings, and
868 included the broadening of participation to include all relevant stakeholders (Lessons 7 and

869 9), and the management of slow variables and feedbacks across social and ecological systems
870 (Lessons 4-6). We concluded that achieving the integration and balance required for blue
871 growth will depend upon the success of holistic approaches (Lesson 12) such as Ecosystem
872 Based Management (EBM; Levin et al., 2009), ecosystem-based fisheries management
873 (EBFM; Pikitch et al., 2004, Smith et al., 2007), and ecosystem-centric approaches to
874 aquaculture (Brugère et al., 2018). EBM principles themselves include the need to consider
875 the dynamic nature of marine ecosystems, the importance of adaptive management (Long et
876 al., 2015; 2016), and the effectiveness of aligning top-down and bottom-up controls
877 (Wondolleck and Yaffee 2017). (Although we note that EBM principles differ among
878 management frameworks and stakeholders - e.g., Long et al., 2016). Finally, monitoring and
879 scientific advice were critical in the historic case studies (Lesson 11), and are accepted as
880 being fundamental for EBM and are now codified in marine policy worldwide (Day, 2008,
881 Van Hoey et al., 2010).

882

883 Collectively, therefore, our findings are expected given present understanding of social-
884 ecological systems. Despite this, we found only one of our ten Recommendations was
885 comprehensively addressed in both the EU and FAO agendas (EC, 2017a, FAO, 2017) (Table
886 3): Recommendation B, including and consulting stakeholders early in the process and in
887 ways that empower them as stewards of the marine environment (EC, 2014, United Nations,
888 1992). Yet, our work indicates even this inclusion may not go far enough. Historical case
889 studies highlighted the diversity of values and needs that different stakeholder groups may
890 have - but neither blue growth agenda explicitly considers this diversity. While the
891 involvement of stakeholders is a necessary feature of fisheries management (e.g., EU, 2002,
892 United Nations, 1992, Reed, 2008, Stephenson et al., 2016), our findings indicate that when
893 the desires of only a subset of stakeholders are considered, short-term ambitions may be
894 prioritized over long-term sustainability, and the perspectives and needs of the weakest
895 stakeholders may be overlooked (Lesson 9). Again, while not addressed in the FAO or EU
896 agendas, this possibility *has* previously been identified (e.g. Cardinale et al., 2017, Cohen et
897 al., 2019). Finally, we determined that these concerns may in fact be exacerbated, by equal –
898 but not equitable - or open access (Lesson 10).

899

900 We found our other nine Recommendations were at best only indirectly considered in the EU
901 and FAO blue growth agendas, and several were not taken into account at all (see Table 3 and

902 SOM 2). Our Recommendations are supported by case studies that span broad geographical,
903 ecological, social, and temporal ranges and are echoed in the wider scientific literature. Our
904 results suggest that there is a considerable misalignment between blue growth agendas, the
905 lessons provided by history and our current understanding of the social-ecological systems
906 they aim to support. Managers and decision-makers interested in blue growth should
907 carefully consider the Recommendations from the historical case studies presented herein and
908 determine how blue growth agendas can be improved based on these lessons from history.

909

910 A final important outcome of our work is that not all of the objectives of a blue growth
911 agenda may be achievable simultaneously (Recommendation D). The historic case studies
912 clearly showed an inherent paradox within the concept of blue growth: whereby economic
913 growth is claimed to be compatible with ecological sustainability and social equity. This
914 situation is rarely achieved in the present-day (e.g., Andriamahefazafy et al., 2019;
915 Bogadóttir et al., 2019), and we show that this was also the case in the past. This reality is not
916 addressed in the blue growth agendas considered in this study, but also unlike many of our
917 other findings, it is not conveyed within ecosystem-based approaches and mandates. We
918 therefore contend it is crucial that blue growth agendas accept these realities and distinctly
919 articulate how they aim to address them. For example, well-defined prioritization of aims will
920 be essential for decision-making, and trade-offs among goals and user groups (Brown et al.,
921 2001, Jennings et al., 2016) will be inevitable if blue growth is to be achieved. Moreover, we
922 encourage proponents of blue growth agendas to avoid *assuming* all aims can be achieved
923 simultaneously, and, in particular, to carefully consider whether and how the proposed
924 economic growth is compatible with social and ecological goals.

925

926 ***Placing historical perspectives into present-day contexts***

927 Our historical case studies focused on wild capture fisheries and some aquaculture systems,
928 and these provided broad Recommendations for blue growth agendas, however they were
929 limited in overall scope and reflect only a subset of possible blue growth opportunities (e.g.,
930 OECD, 2016, United Nations, 2015, United Nations, 2016). Further valuable insights are
931 certain to arise from historical study in other sectors, e.g. freshwater fisheries, mining and
932 materials, renewable energy generation, and recreation (Carpenter et al., 2009, United
933 Nations, 2005). One of the greatest challenges to blue growth will be managing the

934 interactions among the different industries and sectors (e.g., Klinger et al., 2016), a theme not
935 well covered by the historical case studies, but one that is in critical need of attention
936 (Goodsir et al., 2015, United Nations, 2005, United Nations, 2016). Hence, our
937 Recommendations should not be considered a complete review of historical blue growth, but
938 rather an exemplar of the rich resources available from history.

939

940 The agendas that seek to achieve blue growth are relatively new (EC, 2012, FAO, 2017).
941 Thus, while we did not find most of our cross-cutting Lessons and Recommendations
942 adequately represented in either the EU or FAO agendas, they might be under consideration
943 at regional or national levels, or within other emerging agendas. However, where appropriate
944 regional documentation was sourced (e.g., EC, 2013, EC, 2017b), we found that they were
945 not considered in greater depth (Table 3). This study offers an approach for the explicit
946 analysis of historical blue growth, and study within additional regions and cultural contexts
947 will provide further broad lessons from history that may help to achieve blue growth. Such
948 work could provide further insights in other sectors, and address regionally specific cultural
949 factors, customs, stakeholder perspectives and goals. Variations in the achievement of blue
950 growth at different spatial scales, and the likely future challenges and opportunities in
951 specific areas may be elucidated. This should indicate which Recommendations are most
952 applicable in a given locale. We therefore suggest future agendas would benefit from
953 engaging historians and social scientists in assessments of past local marine resource use or
954 that from analogous ocean regions.

955

956 As with all information sources, historical resources contain uncertainties. Common concerns
957 include the incompleteness of data, the diversity of data types or sources, or uncertainties and
958 biases that are unfamiliar to marine resource managers and practitioners (e.g., McClenachan
959 et al., 2015). Despite these very real issues, increasing examples from the literature highlight
960 that best practices can be used in overcoming these challenges (e. g., Fortibuoni et al., 2010,
961 MacKenzie and Ojaveer, 2018, McClenachan et al., 2015, Sguotti et al., 2016, Thurstan et al.,
962 2016). Thus, we urge managers to work with researchers that are well-versed in the historical
963 and social sciences, who can aid in understanding historical resources and their interpretation,
964 as opposed to assuming that novel sources render historical data unreliable.

965

966

967 **Conclusions**

968
969 Today's blue growth agendas aim to maintain and expand the benefits we derive from the
970 oceans, and to do so in a balanced, integrated and equitable way. Blue growth principles are
971 closely aligned with ecosystem-based approaches and resilience thinking, and so should help
972 support the achievement of the UN's sustainable development goals. So far, these agendas
973 have sought to develop approaches and achieve outcomes without reference to examples of
974 successful and/or unsuccessful blue growth. We identified 20 historical cases of blue growth,
975 and, from these determined fourteen Lessons and 10 broadly-applicable Recommendations
976 for blue growth agendas. This is the first time, to our knowledge, that questions have been
977 asked about the novelty of blue growth, and whether what is considered to be 'blue growth'
978 today is reflected in people's use of the sea through time. We are aware of no other research
979 on blue growth with the geographical and temporal breadth, or covering a similar range of
980 social-ecological systems, as that explored in the present study. Our findings are supported by
981 the wider literature, showing that they are scientifically sound, however despite this, the
982 Recommendations we propose are poorly addressed in the current agendas. Given that blue
983 growth is emerging as a concept at the forefront of modern ocean management and policy,
984 and because knowledge on the pathways to success and failure are lacking, such advice is
985 urgently needed.

986
987 The Lessons and Recommendations cross-cut the case studies disparate in location, time
988 period, and social-ecological system and are supported by the literature, indicating their broad
989 applicability. They indicate that achieving blue growth requires appreciation of differing
990 temporal, spatial, economic, and other scales, and knowledge of the interconnections and
991 feedbacks within the socio-ecological system of concern as well as of extrinsic political,
992 economic and environmental factors. These results can inform viability and risk assessments
993 for blue growth, and can help to build resilience and adaptive capacity. Critical appraisal and
994 prioritization of the aims of blue growth will be essential for decision-making, and trade-offs
995 among goals and user groups will be inevitable if blue growth is to be achieved – but the
996 attainment of all goals simultaneously may not be possible. Collaboration between different
997 sectors and neighbouring regions will greatly improve the chances for success. Decision
998 makers must also be aware that blue growth can be gained and lost, and its maintenance over
999 time once achieved is not guaranteed.

1000

1001 Reflecting, engaging and capturing historical knowledge within our present-day
1002 understanding of socioecological systems is a timely step, because we live in a unique
1003 moment in human history. We have not previously consumed such a large proportion of the
1004 Earth's resources so quickly, but neither have we held so much knowledge about the
1005 consequences of our own actions (Krause, 2018). By assimilating past experiences with
1006 current knowledge we identified crucial aspects of blue growth that need to be addressed in
1007 the agendas. We hope this research will motivate further future exploration of past human
1008 engagement with the seas, that may elucidate other lessons for blue growth, and so avoid the
1009 collective cultural amnesia that often causes us, as a society, to repeat past mistakes.

1010

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1025

1026 **Data Availability Statement**

1027

1028 Data sharing is not applicable to this article as no new data were created rather data were
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1030 figured and tabulated within the manuscript or supplementary information of this article.

1031

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Tables

Table 1. Selected case study overviews with positive and negative outcomes and drivers in relation to blue growth, together with lessons for blue growth agendas today. Blue growth (BG) overarching criteria are (1) achieving growth, (2) maintaining balance, (3) implementing smart solutions and (4) achieving integration. Full case study examples (with references) can be found in SOM1.

	Stock, system, or service	Period	Successes in blue growth context		Failures in blue growth context		BG Criteria	Lessons for Blue Growth
			Outcomes	Drivers	Outcomes	Drivers		
1	Galway Bay, Ireland: mixed capture fishery	1820–1860s	<p><i>Pre-1850s and pre-trawl:</i></p> <ul style="list-style-type: none"> • Community-based management of fishery • Equitable access • Sustainable use of marine resources 	<ul style="list-style-type: none"> • Local democratic control of resource • Desire for social equity and to retain economic control • Desire to maintain resource sustainability • Local stakeholders’ traditional ecological knowledge valued by management regime 	<p><i>Post-1850s and post-trawl:</i></p> <ul style="list-style-type: none"> • Overexploitation of the resource • Decline in social-economic equity due to power imbalance (trawlers in a financial and practical position to force out non-trawling locals) 	<ul style="list-style-type: none"> • Shift from local to national political control • Desire for economic growth and use of new technology • Local stakeholders’ traditional ecological knowledge no longer valued by management regime 	(1), (2)	<ul style="list-style-type: none"> • Importance of stakeholder engagement, value of traditional knowledge • Prioritizing one value (economic) over all others can undermine BG success • Without appropriate management controls, technological innovation can lead to overexploitation • Failure to understand and address limits to industry growth has consequences, including system collapse • Benefits to stakeholders may be unequal/incompatible, creating conflict
7	Dugong fisheries in SE Queensland (focus on oil)	1800–1969	<ul style="list-style-type: none"> • Rapid industrial growth • Successful merging of new technology with traditional practices • Equitable access at times • Dugong fishery contributed positively to key periods of social change 	<ul style="list-style-type: none"> • Transfer of traditional knowledge • Importance of fishery for local needs • Collaboration across resource groups 	<ul style="list-style-type: none"> • Failure to grow industry despite potential global demand • Overexploitation • Inequitable access and decline of stakeholder engagement • Lost cultural services for indigenous peoples (spiritual & cultural value) 	<ul style="list-style-type: none"> • Inability to maintain consistent supply • Adulteration of product with other oils • Failed management and lack of scientific understanding, especially challenging biological characteristics of stock (life history, behaviour) • Technological advances impacted social equity 	(1), (2)	<ul style="list-style-type: none"> • Importance of appropriate management supported by ecological knowledge. • Importance of stakeholder engagement and knowledge. • Importance of multiple drivers beyond economic growth, relevance of extrinsic drivers. • Value of fisheries for social change. • Failure to understand and address the limits to industry growth may cause system collapse
14	Lobster fisheries, West coast of Sweden	1870–	<p>Pre-1890s:</p> <ul style="list-style-type: none"> • Landings and exports increased without impacting sustainability <p>Modern time:</p> <ul style="list-style-type: none"> • Shift to sustainable fisheries 	<ul style="list-style-type: none"> • Technological advance and regulation reduced lobster mortality and stabilised populations encouraging growth • Rights assigned to local fishers, limited access 	<p>Post-1951:</p> <ul style="list-style-type: none"> • Expanded access to fishery led to growth in numbers of fishers • Decline in stock size, despite management measures 	<ul style="list-style-type: none"> • Technological advance enabled exploitation beyond biological limits • Lack of restrictions in access and monitoring of recreational sector • Inadequate management 	(1), (2)	<ul style="list-style-type: none"> • Open access is not the same as equitable access, and does not produce the same outcomes. • Monitoring and regulation of all sectors is necessary for sustainability.

Table 2. The fourteen cross-cutting Lessons for blue growth and the historical case studies that contributed to the formation of each lesson. Details of all numbered case studies are listed in **SOM 1** (with sources), and example case studies are included in Table 1.

Cross-cutting Lessons for blue growth	Case studies used
1. To determine whether blue growth has occurred, outcomes should be assessed over a range of scales.	1, 3-7, 10, 13, 17
2. The prioritisation of short-term gains can lead to long-term losses in blue growth.	1, 3, 5-9, 10b-c, 13
3. Failure to understand and address limits to industry growth may have ecological, social and economic consequences, including system collapse.	1, 6-7, 9, 10c, 16
4. Marine socioecological systems are dynamic: growth can be unpredictable, nonlinear, and can be attributed to multiple factors.	4, 5, 7, 8, 10a-b, 10e, 16, 17, 18, 20
5. Drivers and events occurring outside the immediate system can critically impact the achievement and maintenance of blue growth.	2-8, 10a-d, 11, 15-17, 18
6. Supporting systems may be important for translating innovation into blue growth.	4, 6, 9, 10b, 17, 19
7. Stakeholders hold diverse perspectives and socioecological knowledge, and this can be leveraged to support blue growth.	1-3, 6-7, 10a, 15-17
8. Environmental stewardship can support blue growth and may be facilitated by cultural and social attributes as well as economic incentives.	1-5, 10a-b, 16, 18
9. The benefits of blue growth may be unequal or incompatible across stakeholder groups, which can create conflict or limit growth if one group's needs are prioritised above others.	1, 7, 9, 11
10. Equitable access does not always correspond with open access nor produce the same outcomes.	1, 3, 7, 14, 20
11. Management based on scientific knowledge and supported by ongoing monitoring may be key for blue growth.	4, 6-7, 11-13, 14-17, 19
12. For blue growth to be maintained, policy and management must be flexible, responsive, and adopt a whole-system view, including across multiple jurisdictions when required.	3, 7-9, 10a, 12, 19
13. Regulations (whether top-down or bottom-up) can facilitate and maintain blue growth, but adequate enforcement and community buy-in can be critical.	1-4, 10a, 13-15
14. Growth, ecological sustainability and social equity may not be achieved simultaneously meaning trade-offs may be necessary.	1, 8, 9, 10b-d, 12

Table 3. Ten Recommendations for future blue growth derived from the cross-cutting Lessons and their representation within FAO and EC blue growth agendas (EC, 2012, EC, 2014, EC, 2017a, EC, 2018, FAO, 2017). For full discussion of the Recommendations see SOM 3.

Recommendations	Lessons	In EC documents?	In FAO documents?
<i>When planning for future blue growth...</i>			
A. Define the temporal and spatial scales across which blue growth will be measured.	1-3, 4, 9	Somewhat: Spatial boundaries delineated e.g., the Baltic Sea region; maritime spatial plan implies spatial scales will be defined.	Not mentioned: Recognises the need to work across global and national scales, but does not mention the importance of scales to blue growth measurement.
B. Identify and engage stakeholders in the decision-making process as early as possible.	7, 8, 13	Yes: Regional blue growth strategies e.g., the EU strategy for the Adriatic and Ionian regions, have involved key stakeholders from the early stages of development, while consultation with stakeholders is a core principle of the EU’s blue growth policy.	Yes: Objectives include creating conditions that enable and empower resource user groups, where they are also stewards.
C. Aim to align technological advancement and economic growth with other system attributes (e.g., social and culture values, community supported regulations).	2, 3, 6, 8, 13	Somewhat: Some regional strategies highlight the importance of fostering regional cultural heritage and resilient coastal communities e.g., the Adriatic and Ionian region. Small-scale fisheries development is prioritized in some regional initiatives.	Somewhat: Suggests blue growth should be a catalyst for innovation and investment that supports food security. Promotes efficient seafood value chains, as well as empowering communities and improving their resilience to crises.
D. Be aware that not all blue growth criteria may be achievable simultaneously; have a plan for deciding trade-offs	9, 14	Somewhat: A consensus that multiple factors affect growth that will need to be dealt with in various ways, both within and across industries. But little about how trade-offs will be addressed or priorities determined.	Not mentioned: Individual countries identify priority blue growth areas that they wish to strengthen, but no further detail is provided.
<i>In enacting management to support blue growth...</i>			
E. Focus on facilitating equitable access, but recognise the potential for actions to impact user groups in different ways and mitigate appropriately.	7, 9, 10, 14	Somewhat: The EU Cohesion Fund aims to reduce economic and social disparities, European Social Fund aims to promote job creation, and other funds will focus upon outer or lower-income regions; however, it is unclear how differing needs of user groups will be addressed (including greater/lesser ability of some to access opportunities).	Yes: Noted that blue growth should be a catalyst for poverty alleviation, improve livelihoods and food security.

<p>F. Adopt a holistic view of the system based on the best available science, specifically include people.</p> <p>1-5, 7-8, 12</p>	<p>Somewhat: A holistic approach is championed via the Integrated Maritime Policy, but implementation of holistic management is rarely explicitly mentioned in reference to blue growth.</p>	<p>Somewhat: Blue growth implementation incorporates the 3 pillars of sustainable development: social, environmental and economic, yet the integration of these pillars into a holistic view is less well developed.</p>
<p>G. Enact regulations that are enforceable, appropriately resourced, and align top-down and bottom-up controls.</p> <p>6-9, 13</p>	<p>Somewhat: Awareness that enforcement and resourcing adequacy are not presently aligned across member states, but actions to overcome this are not mentioned. Awareness that investment in top-down regulation and bottom-up initiatives are of value, but little on the potential to align the two.</p>	<p>Somewhat: Promotes sustainable growth, implementation of code of conduct for responsible fisheries and ‘related instruments to restore stocks’, and combat IUU. Dependents should be empowered and approaches to promote growth should be incentivized.</p>
<p>H. Enact management that can respond and adapt to changing socioecological conditions.</p> <p>4-5, 11-12</p>	<p>Somewhat: Maritime spatial plans aim to adapt to changing conditions, aided by ongoing monitoring.</p>	<p>Somewhat: Suggests blue growth should be a catalyst for policy development and sustainable management; promotes ecosystem service regulation and restoration.</p>
<i>After blue growth agendas are ratified...</i>		
<p>I. Ensure short-term gains do not undermine longer-term growth.</p> <p>2, 3</p>	<p>Somewhat: Aim to ensure resources can be enjoyed by future generations, but trade-offs between short and long-term gains are not mentioned.</p>	<p>Somewhat: Promotes responsible growth. Notes that when individual interests were pursued previously, these can exclude social benefits.</p>
<p>J. Ensure continuous monitoring of the system as well as extrinsic events and drivers, and that data are accessible and used to inform and ensure continued blue growth.</p> <p>4, 5, 11, 12</p>	<p>Somewhat: Efforts are being made to make marine data resources freely available and to develop and maintain databases, e.g., EMODnet, but how extensive and well-resourced monitoring will be ensured across member states is unclear. In addition, the EU Commission has sought cooperation with non-EU countries that share common sea basins, the impacts of extrinsic events is not mentioned.</p>	<p>Not mentioned: Acknowledges blue growth approach must be flexible and foster co-operation between countries, but doesn’t consider monitoring or drivers.</p>

Figures legends

Figure 1. Schematic of the approach used to identify case studies from the historical literature, and derive cross-cutting Lessons and Recommendations using the EU and FAO blue growth agendas as a framework (FAO, 2017, EC, 2012, EC, 2018, EC, 2017a, EC, 2014). The full list of cross-cutting Lessons and Recommendations are provided in Tables 2 and 3, respectively.

Figure 2. Locations of the 20 historical case studies (a), and the time period that each case study spanned (b), together with key showing whether the case study refers to single species or mixed species wild capture fishery, or aquaculture.

Figure 3. Common trajectories of blue growth (left). Blue growth relies upon a balance (right) between economic growth, social equity and ecological sustainability. If one is prioritized at the expense of the other factors (indicated by the width of the arrows on the right) blue growth may accelerate or be impeded. (a) Unbalanced growth: economic investment drives rapid blue growth initially, but at the cost of social equity and ecological sustainability, which eventually forces the rate of growth to slow or even contract (case studies 1, 3, 7, 8 and 13). (b) Delayed unbalanced growth: economic investment occurs at the expense of social equity and ecological sustainability, declines in growth are delayed due to innovation, but eventually contraction occurs (case studies 5, 6, 9, 18 and 20). (c) Recovery of growth: blue growth occurs then contracts or declines (inset box indicates trajectory in (a)), but due to improvements in ecological sustainability and social equity, growth can recommence. However, in some cases recovery can only occur if ecological sustainability is prioritized, at least in the early stages (case studies 4, 10, 11, 12, 14 and 16). (d) Balanced growth: blue growth occurs by balancing economic growth, social equity and ecological sustainability. Growth may be slower compared to (a)–(c) (case studies 2, 15 and 17 and 19).

Figure 4. Timeline and diagrammatic summary of the events, outcomes (aquaculture and fisheries production), drivers and trajectories of blue growth in the Lagoon of Venice, Italy (case study 3), and the lessons for blue growth (grey speech bubbles) derived from this case study. Includes depictions of historic and traditional artisanal fishing boats and gear (from Pellizzato et al., 2011, Provincia di Venezia 1985, Silvestri et al., 2006). Data from: Libralato

et al. (2004), Solidoro et al. (2010), Silvestri et al. (2006) and Fortibuoni et al. (2014). Outcomes (shaded bar) are distinguished as those interpreted to be largely sustainable (white), less sustainable/unsustainable (grey-black) and uncertain (broken line).

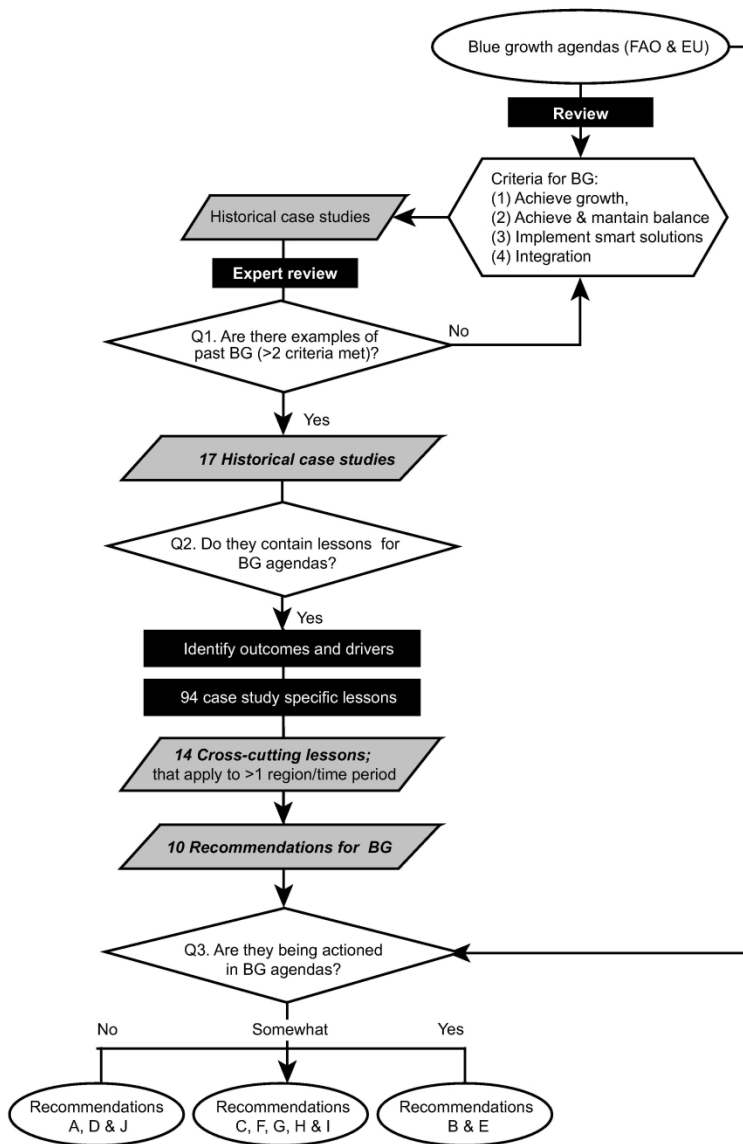
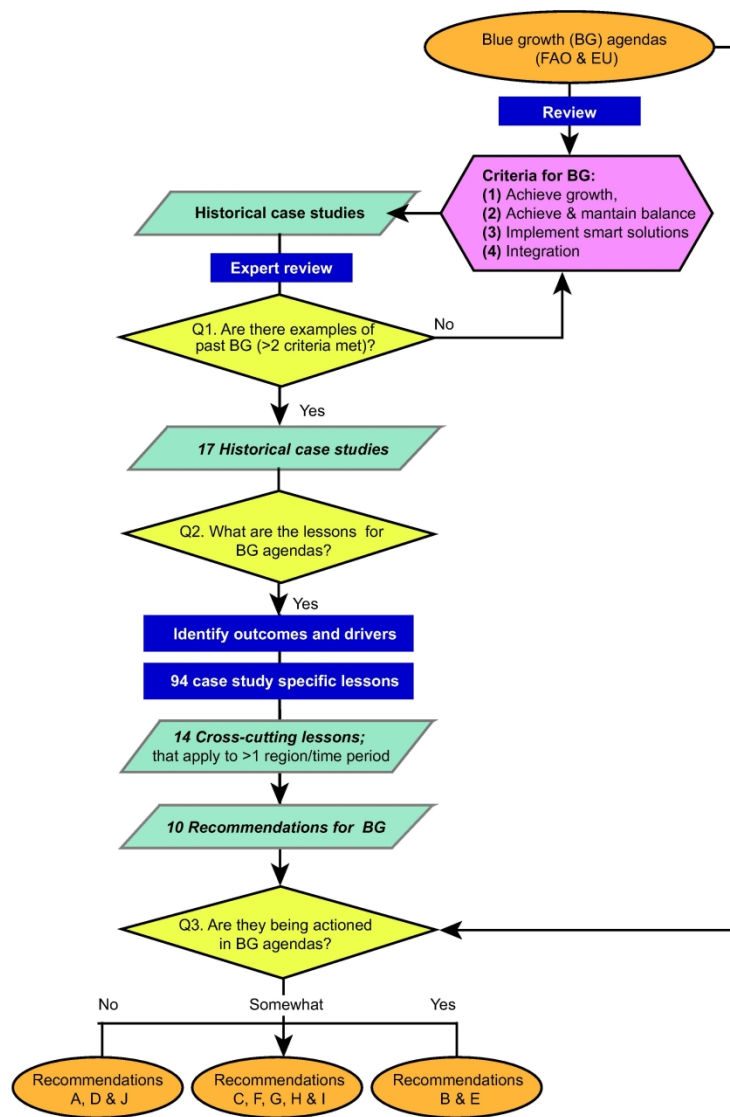


Fig. 1 Caswell et al. 2019

Figure 1. Schematic of the approach used to identify case studies from the historical literature, and derive cross-cutting Lessons and Recommendations using the EU and FAO blue growth agendas as a framework (FAO, 2017, EC, 2012, EC, 2018, EC, 2017a, EC, 2014). The full list of cross-cutting Lessons and Recommendations are provided in Tables 2 and 3, respectively.

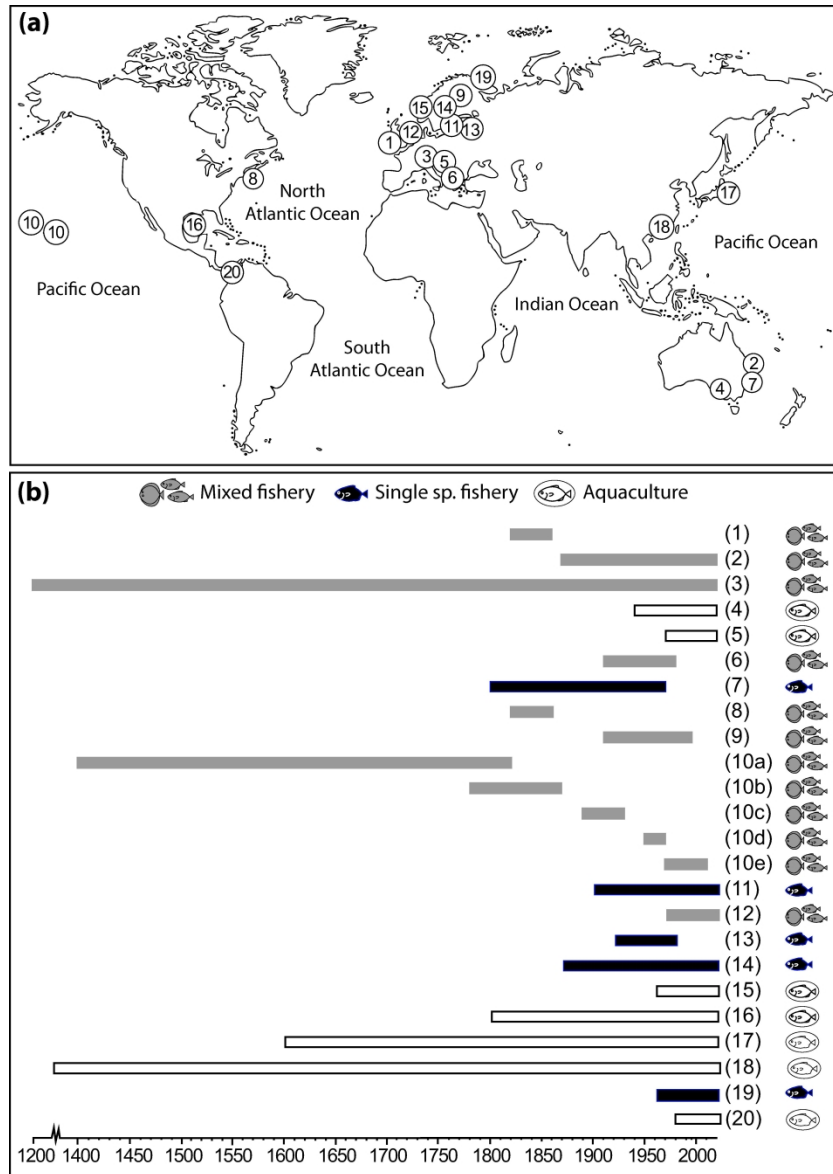
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Caswell et al. 2019 Fig. 1

Figure 1. Schematic of the approach used to identify case studies from the historical literature, and derive cross-cutting Lessons and Recommendations using the EU and FAO blue growth agendas as a framework (FAO, 2017, EC, 2012, EC, 2018, EC, 2017a, EC, 2014). The full list of cross-cutting Lessons and Recommendations are provided in Tables 2 and 3, respectively.

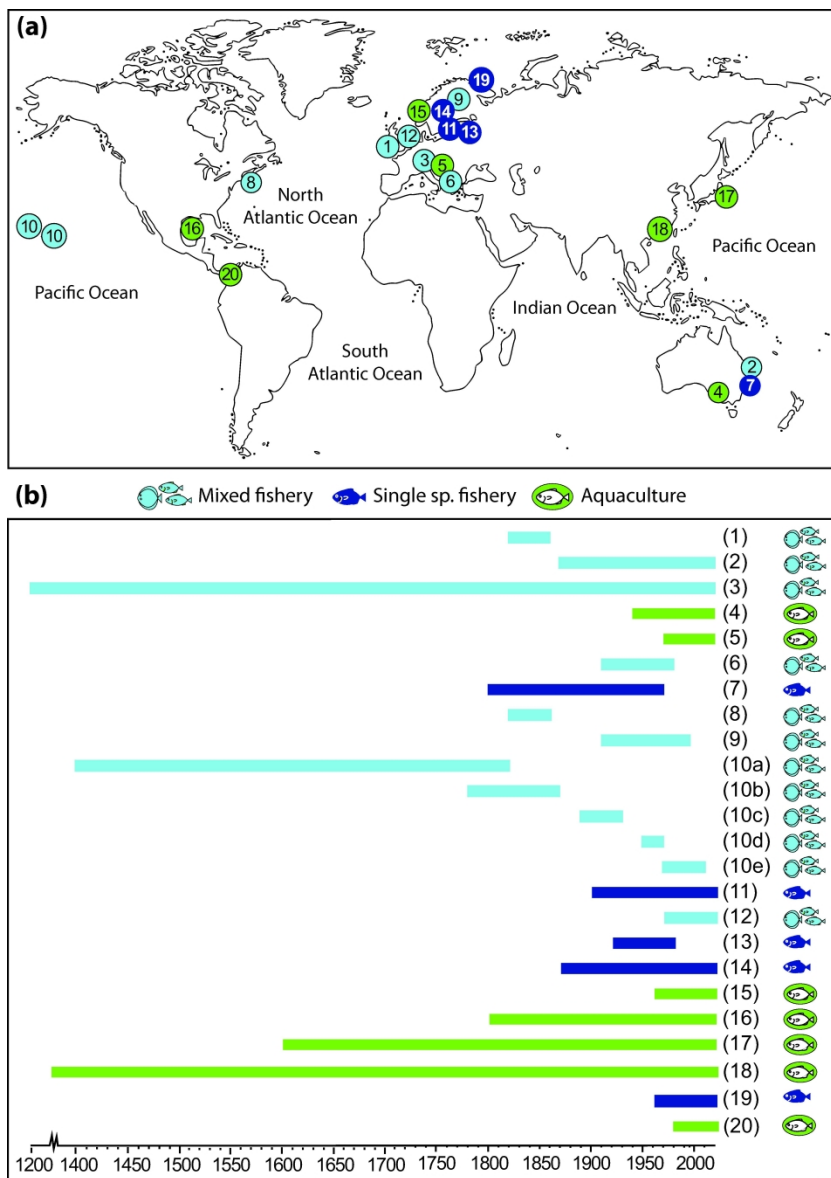
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Caswell et al. 2019 Fig. 2

Figure 2. Locations of the 20 historical case studies (a), and the time period that each case study spanned (b), together with key showing whether the case study refers to single species or mixed species wild capture fishery, or aquaculture.

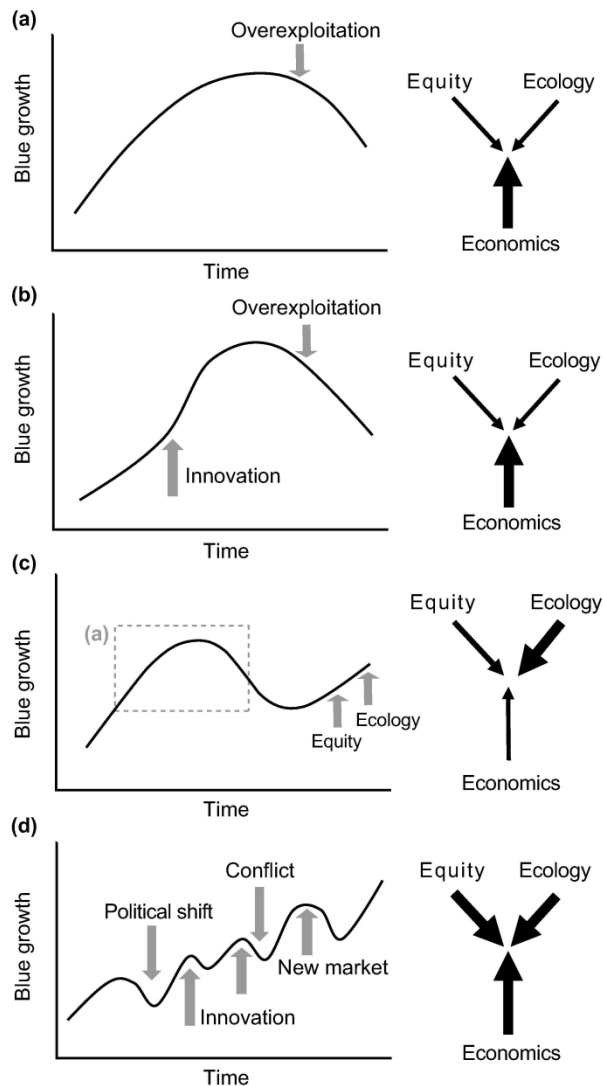
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Caswell et al. 2019 Fig. 2

Figure 2. Locations of the 20 historical case studies (a), and the time period that each case study spanned (b), together with key showing whether the case study refers to single species or mixed species wild capture fishery, or aquaculture.

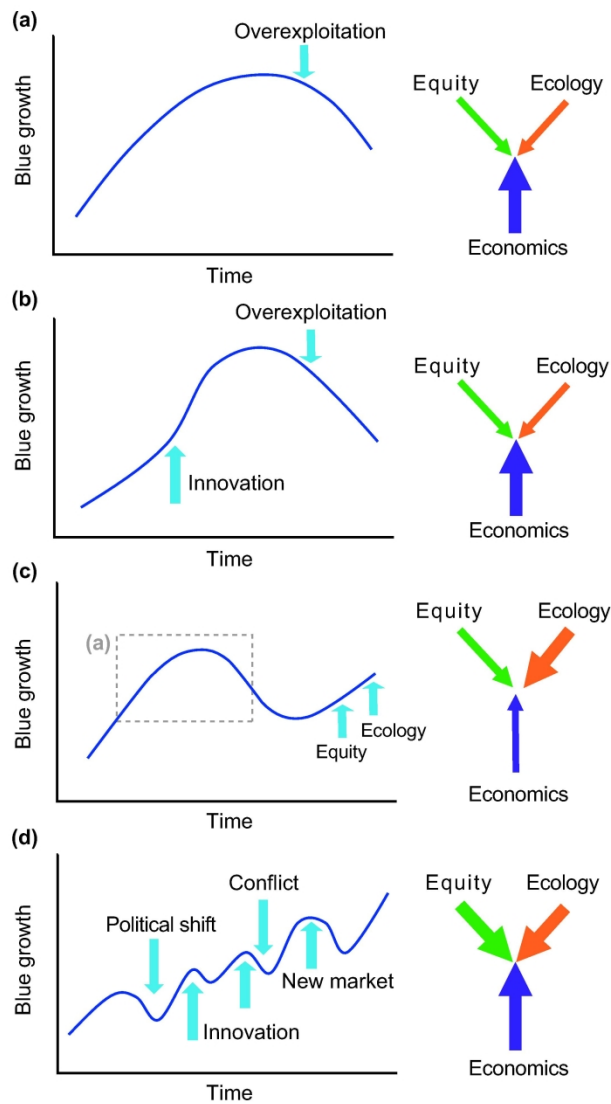
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Caswell et al. 2019 Fig. 3

Figure 3. Common trajectories of blue growth (left). Blue growth relies upon a balance (right) between economic growth, social equity and ecological sustainability. If one is prioritized at the expense of the other factors (indicated by the width of the arrows on the right) blue growth may accelerate or be impeded. (a) Unbalanced growth: economic investment drives rapid blue growth initially, but at the cost of social equity and ecological sustainability, which eventually forces the rate of growth to slow or even contract (case studies 1, 3, 7, 8 and 13). (b) Delayed unbalanced growth: economic investment occurs at the expense of social equity and ecological sustainability, declines in growth are delayed due to innovation, but eventually contraction occurs (case studies 5, 6, 9, 18 and 20). (c) Recovery of growth: blue growth occurs then contracts or declines (inset box indicates trajectory in (a)), but due to improvements in ecological sustainability and social equity, growth can recommence. However, in some cases recovery can only occur if ecological sustainability is prioritized, at least in the early stages (case studies 4, 10, 11, 12, 14 and 16). (d) Balanced growth: blue growth occurs by balancing economic growth, social equity and ecological sustainability. Growth may be slower compared to (a)–(c) (case studies 2, 15 and 17 and 19).

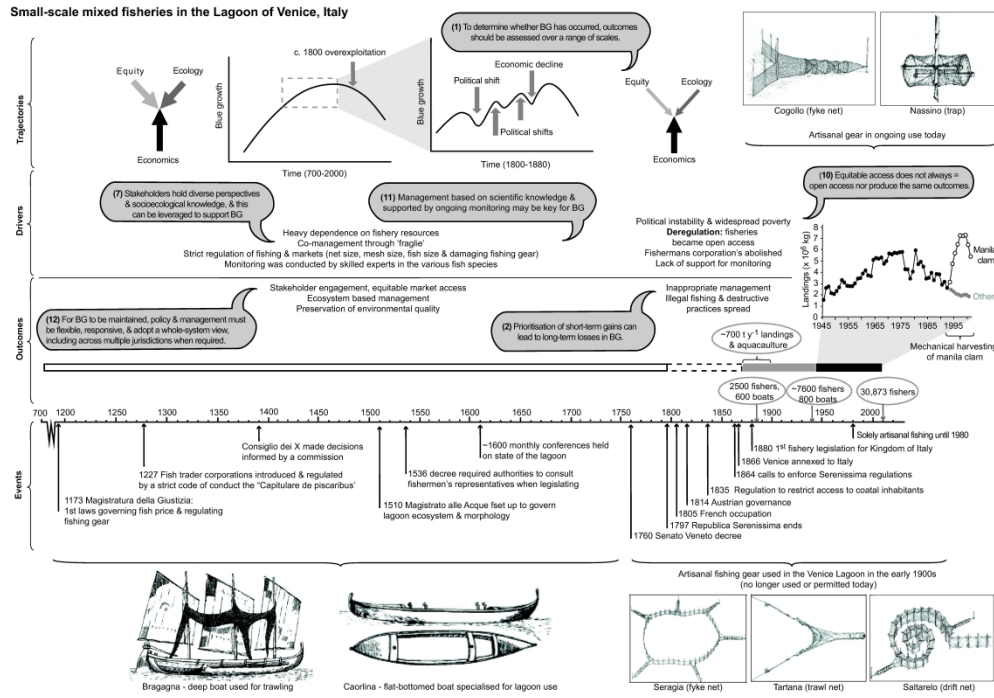
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Caswell et al. 2019 Fig. 3

Figure 3. Common trajectories of blue growth (left). Blue growth relies upon a balance (right) between economic growth, social equity and ecological sustainability. If one is prioritized at the expense of the other factors (indicated by the width of the arrows on the right) blue growth may accelerate or be impeded. (a) Unbalanced growth: economic investment drives rapid blue growth initially, but at the cost of social equity and ecological sustainability, which eventually forces the rate of growth to slow or even contract (case studies 1, 3, 7, 8 and 13). (b) Delayed unbalanced growth: economic investment occurs at the expense of social equity and ecological sustainability, declines in growth are delayed due to innovation, but eventually contraction occurs (case studies 5, 6, 9, 18 and 20). (c) Recovery of growth: blue growth occurs then contracts or declines (inset box indicates trajectory in (a)), but due to improvements in ecological sustainability and social equity, growth can recommence. However, in some cases recovery can only occur if ecological sustainability is prioritized, at least in the early stages (case studies 4, 10, 11, 12, 14 and 16). (d) Balanced growth: blue growth occurs by balancing economic growth, social equity and ecological sustainability. Growth may be slower compared to (a)–(c) (case studies 2, 15 and 17 and 19).

110x180mm (600 x 600 DPI)



Caswell et al. 2019 Fig. 4

Figure 4. Timeline and diagrammatic summary of the events, outcomes (aquaculture and fisheries production) and drivers of blue growth in the Lagoon of Venice, Italy (case study 3), and the lessons for blue growth (grey speech bubbles) derived from this information. Includes depictions of historic and traditional artisanal fishing boats and gear (from Pellizzato et al. 2011, Provincia di Venezia 1985, Silvestri et al. 2006). Data from: Libralato et al. (2004), Solidoro et al. (2010), Silvestri et al. (2006) and Fortibuoni et al. (2014). Outcomes (shaded bar) are distinguished as those interpreted to be largely sustainable (white), less sustainable/unsustainable (grey-black) and uncertain (broken line).

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