Chapter 19
Bivalve Gardening

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Abstract From an increasing awareness of sustainable food production, the promise of the "blue revolution" and campaigns to ameliorate the marine environment, seafood gardening has emerged from motivated local citizenry as a local food production phenomenon. Bivalve gardening, primarily manifested as oyster gardening, is a relatively new concept, slowly gaining traction worldwide. Terrestrial and marine gardening share the same principles of cultivating organisms and providing ecosystem goods and services. The main differences concern the growing medium – and legislation regarding use and access to gardens. Bivalves appear to be an ideal group of marine organisms for local production, they are low maintenance and do not require external food supplies as they feed directly by filtrating their surrounding growing medium. However, the cultural services provided by bivalve gardening range from social organisation to sustainable engagement; and require certain pillars such as clear objectives, support from the local community and government, dedicated volunteers, native bivalve seed availability, training, and realistic objectives. Moreover, the development of new gardens raises fundamental issues including food safety, regulation, and marine spatial planning. We use two case studies to illustrate different approaches to bivalve gardening: (1) in the U.S. several bivalve gardening initiatives are taking place, it is often referred as oyster gardening and initiated as a bivalve habitat recovery efforts, (2) in Denmark in Europe, several projects have started directly as bivalve gardens for food provisioning and are managed by local associations.

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Abstract in Chinese 摘要:在人们对可持续食物产出、“蓝色革命”美好愿景、海洋环境改善越来越关注的背景下,海洋生物资源恢复已经成为广大民众比较接受的食物生产方式。双壳贝类,尤其是牡蛎的种群资源恢复,作为相对较新的概念已经在世界范围内逐渐普及开来。陆基和海水养殖的基本原则都是进行生物培育并且提供生态产品和服务,其主要区别在于养殖媒介以及养殖许可的审批和立法的过程。由于独特的滤食特性且日常维护成本较低,双壳贝类是众多海洋生物中食物供给功能较强的理想物种,。然而,双壳贝类种群资源恢复活动所提供的文化服务功能涵盖社会组织到公众可持续的参与,这需要当地社区和政府的支持、热心的志愿者参与、足量本地苗种的供应、相关技术培训和实际的实施方案制定等作为有效支撑。。此外,新模式的发展也进一步激起了人们对于食品安全、法规和海洋空间规划等基础性问题的讨论。我们用两个案例研究来说明不同的双壳贝类养殖的方法和提供的生态服务:1)在美国,已经在多处开展了双壳贝类(主要是牡蛎)种群资源恢复行动,旨在重建双壳贝类的栖息地; 2)在丹麦,多个双壳贝类种群资源恢复项目由当地协会进行管理,主要目的是提供食物供给功能。

Keywords Bivalve gardening · Cultural services · Oyster · Mussel · Non-commercial aquaculture · Community

关键词 双壳贝类种群资源恢复 • 养殖服务 • 牡蛎 • 贻贝 • 非商业性水产养殖 • 社 区

19.1 Introduction

19.1.1 The Bivalve Garden

Bivalve gardening is a non-commercial activity where bivalves such as mussels and oysters are grown for personal consumption. It is often perceived as a novel activity or concept as there is scarce tradition of private production with a physical garden of marine bivalves for personal consumption; there is rather a more established tradition for hand picking and gathering in the wild. Bivalve production is regarded as one of the most sustainable forms of seafood production, as bivalves extract organic matter from their surrounding environment, mainly by filtering phytoplankton, and thus do not require external food sources. Presently there are few examples of bivalve gardens, mainly based on community/association gardening principles using licenced grounds or individually operated in privately owned coastlines.

In a general sense, gardens are multifunctional and provide many cultural services in addition to the provision of food for personal consumption. While bivalve gardens share attributes with terrestrial gardens/allotments, typically hobby-scale with little infrastructure, the marine medium adds an altogether new dimension to food production with many new challenges.

19.1.2 History of Bivalve Gardening

19.1.2.1 From Gathering to Gardening

The development of bivalve gardening in contemporary history follows the development of the paradigm of securing sources of marine animal and vegetable proteins. Marine food production has shifted from gathering to farming at a much slower pace than terrestrial products. Terrestrial farming emerged in the Neolithic Era, ca. 10,000 years ago, through the domestication of terrestrial plants and animals; fundamentally changing human feeding habits and the structure of human life. By comparison, the domestication of aquatic foods has largely developed in recent times (Teletchea 2015). More than 90% of aquatic food domestication took place in the twentieth century while 97% of terrestrial domestication developed more than 2000 years ago (Duarte et al. 2007). Hunting and gathering has almost vanished from a commercial perspective for terrestrial products, while nearly half of global marine products are still extracted rather than cultivated (FAO 2016) from both commercial and recreational fisheries; but also from licenced/regulated hand picking and illegal poaching. Aquaculture has existed for thousands of years, mainly focused on finfish and seaweed, as for instance in China (Rabanal 1988). There are early records of bivalve gardening during the late Holocene in British Columbia where a first nation tribe maintained a garden of butter and littleneck clams (*Saxidomus gigantean, Leukoma staminea*) (Lepofsky and Caldwell 2013). These early gardeners were modifying and transforming the shoreline in order to increase clam production (Groesbeck et al. 2014). More recently, since the seventeenth to eighteenth centuries, oyster ponds on the Atlantic coast of France have been used for family production of oysters.

In recent times, community citizen gardening in the U.S. has developed for marine food consumption, from a movement that originated within bivalve habitat restoration programs in degraded estuarine systems on the East coast. In the Puget Sound shoreline landowners are growing their own bivalves on privately owned beaches or docks, sourcing their bivalve 'seed' and material from commercial bivalve growers (Chase 2017). In France, an activity called "aquaculture de loisir" (recreational aquaculture) could be interpreted to mean bivalve gardening. On the Atlantic coast of France, marshes have been modified to ponds and hillocks as far back as the seventeenth and eighteenth centuries for agriculture, salt ponds, pisciculture, oyster culture, and recreational culture. There, recreational aquaculture represents a social and cultural heritage where oysters were traditionally cultivated in privately owned saltwater ponds ("claires") for familial consumption; nowadays this is shifting towards shrimp culture (Paticat 2007). More recently in Denmark, bivalve gardening is a phenomenon derived not from bivalve habitat restoration but directly targeting food production; the government and private foundations have facilitated its implementation. In Japan, there are a few examples of seafood gardening, mainly focusing on seaweed, and some bivalve gardens also originating from restoration projects. There, personal seaweed growing is termed as an "ownership

system" (e.g in 2005 in Minamata city http://bp.eco-capital.net/bps/read/id/88 or in Hiroshima http://www.haff.city.hiroshima.jp/info/2016/11/8982/). In other parts of the world where bivalve restoration projects exists, such as in Australia, oyster gardening is starting to come to fruition (Simon Branigan, The Nature Conservancy Australia pers. comm.).

19.1.2.2 Food Requirement vs. Sustainable Production

The sea has been historically perceived as a source of inexhaustible resources, either as food or raw material. For centuries bivalves have been extracted for food, often ignoring the ecological consequences such as eutrophication (Jackson et al. 2001). An illustration of the extent of extraction can be seen in shell middens, where in coastal areas around the world, gathered shells were piled up over many generations, covering areas up to 600–700 m long (Andersen 2000) and several meters high (Butler et al. 2019). Most of the coastal areas and estuaries worldwide, where bivalves are endemic, have been affected by direct and indirect anthropogenic impacts of securing food and materials; ranging from overexploitation of bivalves, overfishing, nutrient and toxic substances pollution, introduction of invasive species, climate change, and coastal erosion. These impacts have often lead to devastating ecological consequences such as eutrophication and habitat loss (Beck et al. 2011). Anthropogenic impacts were enhanced from the mid-1900s during the green revolution, through the use of modern agricultural technologies (e.g. genetics, fertilizers) and more efficient use of arable lands to improve food security at high environmental costs (Ausubel 2000). Recently, efforts in dissemination of information and research communication on ecosystem functioning and sustainable production have fomented ocean literacy and citizen consciousness regarding imbalances in coastal ecosystems due to pollution and reduction of stocks from overfishing (Gelcich et al. 2014); as well as the need to provide food for the growing world population. Thus, populations are facing a dilemma between food procurement with current access to a large quantity of very diverse foods at a high environmental price, and sustainable production.

19.1.2.3 Food Culture

Bivalve gardening was also born from the comprehension that food security did not equate sustainable food production. At the end of the twentieth century, some consumers became driven by an interest in understanding the origin of their food (Grunert et al. 2014); with the loss of knowledge in composing a proper diet stemming from an the overabundance in the variety of available food, as described in "The Omnivores Dilemma" (Pollan 2006). Food security in this era also entails a vast amount of exotic and processed foods. A growing proportion of consumers are seeking other choices than those that form their current food environment. Thus, from a perceived loss of food culture, emerged new movements, such as the slow

food movement (www.slowfood.com, accessed on 01/09/2018, still working) in the late 1980s, based on "preventing the disappearance of local food cultures and traditions, counteracting the rise of fast life and combatting people's dwindling interest in the food they eat". The movement includes three concepts of food: (i) GOOD: quality and healthy food; (ii) CLEAN: sustainable production; and (iii) FAIR: price moderation for consumers and producers (Petrini et al. 2012). Slow food movements are also associated with a wide range of other terms such as: conscious eater, citizen eater, omnivore consciousness, food consciousness, local food movement, locavores, and ethical eaters. Community organisations and shared gardens have been a way to propel the slow food movement, and this is also the case for bivalve gardens. These organisations are connecting food, people, and community; they have a high level of consciousness and they illustrate the social engagement of citizens. Members of bivalve garden associations interact, learn, and comprehend the systemic origins of marine food production and often engage and empower themselves to participate in the restoration of coastal ecosystems.

19.1.3 Services and Social-ecological Systems

Bivalve gardens provide a wide range of ecosystem services (Haines-Young and Potschin 2011) with similar social and ecosystem factors (Table 19.1) of urban or community gardens (Cabral et al. 2017; Camps-Calvet et al. 2016). The main services reside in provisioning and cultural services (Table 19.1) driven by the aspiration for sustainable production of healthy local food. They are not only driven by the good will to provide supportive and regulative services to ecosystems disturbed by e.g. eutrophication and overexploitation.

Analogous to terrestrial gardens, bivalve gardens carry varied significance to different people, ranging from recreational, spiritual, or an educational framework. Bivalve gardens are comparable with so-called terrestrial wildlife gardens, sustainable gardens, and green gardening as a form of sustainable aquaculture in their participation in the enhancement of biodiversity and support of wildlife. Bivalve gardens also permit the maintenance of local varieties to increase resilience of local food supply (Barthel et al. 2014).

Bivalve gardens contribute to raising the public consciousness on environmental issues and sustainable farming, as well as the involvement of the community in protecting the environment from eutrophication or overexploitation. In the practice of gardening, there is an inherent educational aspect, where citizens can learn about aquaculture processes, observe and understand nature and seasons, and become more aware of the surrounding marine ecosystems (Tidball and Krasny 2010). Bivalve gardeners can vitalize the coastal area, share and transmit knowledge, and educate local communities and schools. By cultivating their own food, active citizens can trace healthy seafood from start to plate. Citizens engage socially for local support and community building by collaborative production of local food and the space for production. In many cases, community terrestrial gardens have been a

Table 19.1 Social and ecological factors for ecosystem good and services provided by shellfish gardens

	Social factors	Ecological factors
Provisioning services		
Food supply	Production of healthy local food, increase resilience of local food supply	Addition of food for predators in the system
Shell material	Use of shell material for various purposes e.g. construction	Increase clean substratum for settlement.
Source of seed	Restoring breeding stocks	Export of larvae to the surrounding environment
Regulating services		
Water clarification	Improvement of water for bathing	Improvement of habitat for seagrass and macroalgae and improved water status
Nutrient extraction	Potential nutrient credit	Improvement of habitat and water status
Biodiversity	Improving biodiversity, increase resilience of ecosystem	Increase of substratum and habitat for local species
Cultural services		
Learning & education	Experimentation with gardening practice. Teaching local communities and school regarding aquaculture, sustainable growth, blue growth.	Natural shellfish growth
Recreation & entertainment	Experimentation of boat activities at sea	Biophysical change
Physical exercise	Physical activities from shellfish spat manipulation from spat to harvestable product. Maintenance of the crop.	Removal and addition of mussel and wildlife biomass via harvesting and maintenance of the structure and crop
Spiritual & nature experience	Experimentation and connection with nature, relaxation. Invitation to dream and reflexion at sea	Decreased degradation of environment due to heightened awareness
Social engagement/ political empowerment	Engagement toward sustainable food and local support, and a cause that is meaningful to the community at large	More investment and service for sustainable production with increased potential for natural recruitment into fishery
Community building	Experiment in social cohesion with local community and carry a project together	Incremental improved water quality through stewardship activities
Localivore	Contribute to low carbon footprint and consume locally	Reduction in pollution from food transportation
Food traceability & health	Follow healthy omega3 rich seafood from start to plate	
Food quality & gourmet	Experimentation with new recipes, try new food, open horizons, increase in demand for shellfish and other seafood	
Art craft, design, creativity	Use of shell for creations, design shellfish garden landscape	

forum for participation in democratic processes (Ghose and Pettygrove 2014). Like their terrestrial counterparts, many bivalve gardens embody similar community- and civic-bound structures. At these early stages of development, bivalve gardens are, however, generally less integrative and driven principally for deriving supplementary food supplies rather than addressing food security.

From a health and wellness perspective, gardeners are invigorated via the recreational and community aspect of the activity and benefit to well-being (Egli et al. 2016). This is realized through: (i) social activity, (ii) physical activity by manipulating the farm units, boats and live products, (iii) spiritual discovery and therapeutic effects from contact with nature, (iv) creative use of bivalve products (i.e. arts and crafts, design from shells and raw materials, culinary quality experience (Table 19.1), and potential aesthetic aspirations comparable with land art, eco-design).

19.1.4 Bivalve Gardening Challenges

There is typically little spatial limitation for citizens establishing their own terrestrial vegetable gardens, which can exist on roof tops, as hanging gardens, floating gardens, pots in a kitchen etc. A bivalve garden should be located along the coastline, which is restrictive and this raises the issues of ownership and competition for shoreline and coastal water use. It is assumed that the first nation clam gardeners owned the gardening area in proximity to their settlement by controlling access (Lepofsky and Caldwell 2013). Nowadays, depending on the geographically relevant legislation, the coastline may be state or individually owned. In Denmark, a licence for establishing a community garden is delivered by the state, while in many states in the U.S., individual shoreline landowners can operate on their own plot while following federal and state regulation regarding its use.

Several practical reasons ranging from physical, social, and biological constraints (described in Table 19.2) must be taken into consideration in order to establish a bivalve garden, as well as the existing legislation regarding bivalve trade, biosecurity and food safety. Bivalve gardens, founded under the aquaculture framework, are also implicated with issues such as invasive species or diseases, as for bivalve aquaculture (e.g. EU Regulation 1143/2014 on Invasive Alien Species). For instance in the US or Europe, species cultivated in the bivalve garden must be native and locally present, otherwise, prohibited; wild seed comes from the same water body that the bivalve will be cultivated to reduce spread of potential disease and invasive species (see Puget Sound species recommendations). Although, seed from local species can be provided by certified disease-free hatcheries.

In the following two case studies, we focus on two different approaches for bivalve gardens. In the first, the U.S. case study exemplifies the provisioning service as a derivative of supportive and regulative initiatives from citizens and is illustrated

Table 19.2 Constraints to establish a shellfish garden

Constraints	Description
Physical	Adapted growing structures, water depth, storms, waves, physical carrying capacity and access to the coastline.
Biological	Food availability and quality for the shellfish, local presence of the shellfish cultured, production carrying capacity, food safety and water quality (e.g. low faecal coliform numbers, low toxin and heavy metal contaminations (e.g. EU shellfish directive, the US National Shellfish Sanitation Program). The origin of the juveniles should be either local or from disease free hatchery to prevent introduction of new species or disease.
Ecological	Ecological carrying capacity, potential competition with other present native species
Legal	Delivery time for a licence, regulations might not yet exist for licencing this type of activity.
Social	Management issues from a marine spatial planning point of view, potential user conflicts with other coastal activities, biological, physical and economical.
	Social beliefs: toxin, virus, bacterial contaminations are often in people's minds when it comes to shellfish, and some people would not take the risk to grow their own shellfish.
	No socio-ecological memory of shellfish gardens: unlike terrestrial gardening where a vast range of information, tools and guides are available to grow a salad or a chicken, citizens might feel alienated from the shellfish growing.

Table 19.3 Basic components of the two case studies

U.S. SPAT model	Denmark Fjord garden model
Intensive and extensive training opportunities	Workshops with training opportunities with professionals
Year-round, weekly activities and availability	Year-round, weekly activities and availability
Membership with direct incentives	Membership with direct incentives
Compartmentalized elements with individual leadership (committee concept)	Committee concept emerging but not yet fully implemented
Goal oriented; working towards a cause that is meaningful to the community at large.	Hobby, social aspect and mainly food oriented with ocean literacy goals
Availability of activities for all user groups	Availability of activities for all user groups, embraced depending on capability e.g. sick at sea but happy to cook

by the SPAT program (Suffolk Project in Aquaculture Training). In the second case, the provisioning services from bivalve gardens in Denmark are the main driving forces of the various projects and are illustrated by the Fjord garden project (Table 19.3).

19.2 Case Studies

19.2.1 The United States Case Study: Culture, Restoration, and Food Provisioning

19.2.1.1 Origins and Current Status

Seafood consumption and the activities associated with harvesting of seafood are coupled to the cultural heritage of many coastal communities in the United States (Griffith 1999). Identity and traditions in communities with a heritage of working waters has been shaped by historically important commercial species, while the loss of this heritage and its associated traditions is often lamented (Chambers 2006). Such traditions are often manifested in cultural tourism and seafood festivals (Claesson et al. 2005), where culinary customs and the 'waterman' are celebrated and romanticized. Non-commercial harvesting and gathering in bivalve grounds is historically significant for many coastal communities. While small-scale harvesting has been practiced by immigrating populations since European colonization, Native American groups have been harvesting and nurturing bivalve grounds for millennia (Cardinal and Fluharty 2012). Historical perceptions of many bivalve species harvested from the wild have transformed from sustenance foods to cultural staples, or even luxury items, concurrently with the shift from gathering to industrial harvest. Fisheries depletions are a relic of this affection for certain species; oysters, on both coasts, were severely overexploited by the early twentieth century and wild fisheries never returned to their peak production.

Contemporary oyster gardening in the United States began with the decline of the eastern oyster (*Crassostrea virginica*) population in the Chesapeake Bay; due to a combination of diseases, over fishing and diminished water quality in the 1960s (Mackenzie 2007). In many of the eastern coastal states, active restoration programs have essentially developed out of oyster stock and habitat improvement policy. Decades of work in breeding programs founded in the development of resistance to commercially important oyster pathogens, as well as towards increasing standing stocks of breeding oysters are generally viewed as successful (Brumbaugh et al. 2000). Bivalve gardening in the US originated in many of these restoration programs, and many continue to operate with broad membership and public participation under a restoration mandate (Rossi-Snook et al. 2010). Momentum in the growth of bivalve gardening as a phenomenon has shifted to cultivation for personal consumption in many coastal regions.

Numerous examples, from both Pacific and Atlantic coastal initiatives supporting gardening at the community-level, emphasize individual agency in both restoration processes and food production. Bivalve gardening associations and programs exist in nearly every coastal state in the US. Terminology is not standardized at either the popular or the institutional level, where gardening can indicate simply growing bivalves for one's own purposes, or an established method of bivalve population restoration leveraging public participation. Bivalve gardening "programs" in

the US, are typically driven by conservation and/or restoration initiatives, where individuals become 'members' or otherwise obtain a share in the program (e.g. purchasing a 'starter kit' from a conservation group including culture gear, starter seed, and information on husbandry). Bivalve gardening (or grower) "associations" tend to consist of bivalve consuming enthusiasts whom interact on the basis of growing bivalves for personal consumption. These distinctions are not upheld across the US, nor are they exclusive of each other; many groups host blended membership between restoration and personal consumption motivations, which can fluctuate over time. To a degree, this fluid gradient between motivations for food production and restoration represents many societal contemplations of bivalve aquaculture ecosystem services.

Programs and associations are important interfacing fora for the public and the aquaculture industry. Many gardening initiatives in the US stem from the aquaculture industry's development of hatchery-based production, where high quality seed developed for fast growth and disease resistance provide a readily available source of 'seedlings'. Many state agencies (either aquaculture extension programs or regulatory) maintain directories of hatcheries selling seed to the public, readily available through internet search. Wild seed collection is also practiced for several species, for both infauna and epifauna, particularly mussels and clams. Multiple bivalve species are currently cultivated in gardens around the US, segregated by the Atlantic (and Gulf of Mexico) and Pacific coasts. On the Atlantic coast, the eastern oyster (*Crassostrea virginica*) reigns as the most widespread cultured bivalve in the entire US; from the northeast in Maine to Galveston Bay in Texas. This is largely attributed to emphases in oyster breeding programs, hatchery development, and variety (strain) availability. Other principle gardened species include blue mussels (*Mytilus edulis*), and quahogs/littleneck/hard clams (*Mercenaria. mercenaria*). As hatchery technologies develop for Atlantic scallops (*Placopecten magellanicus*), Bay scallops (*Argopecten irradians*), and surf clams (*Spisula solidissima*) it is anticipated that these species will be future candidates for gardening programs on the eastern seaboard. On the west coast, the geographical focus of gardening has resided in the northwest. Species such as Pacific littleneck clams (*Protothaca staminea*), Manila clams (*Venerupis japonica* or *philippinarum*), butter clams (*Saxidomus gigantean*), horse clams (*Tresus spp.*), cockles (*Clinocardium nuttallii*), geoduck (*Panopea generosa*), Olympia oysters (*Ostreola conchaphila*), Kumamoto oysters (*Crassostrea sikamea*), and Pacific oysters (*Magallana gigas*) can be sourced for gardening (Toba, Nosho, Washington Sea Grant Program 2002). While on both coasts many species are available for gardening, the predominant organisms of interest are oysters sourced from existing public or commercial hatchery programs.

19.2.1.2 Organizational Patterns

While programs and associations are an important component of bivalve gardening in the US, the majority of gardeners in many states do not participate in organized initiatives. A large number of gardeners are motivated to grow bivalves for their

own consumption on their own property; private property ownership is an important feature shaping the bivalve gardener demographic. Land and water tenure issues in the US can vary considerably between coastal areas (Dellapenna 2009); often complicated, and in the case of private use of waters, the legal and regulatory framework can be difficult to navigate for the potential gardener. Access to growing waters, and the right to use those waters, may be bound to socioeconomic contexts in a region that could further influence formation and compositional patterns of gardening associations. Much of the land adjacent to accessible bivalve growing areas are privately owned, and as such, the use of those waters is largely restricted to property owners or individuals gaining permission from those owners to work the waters.

Alternatives to the mode of private ownership in gardening are emerging. In addition to the community garden spaces maintained in Suffolk County, NY (described below) there are several examples of functioning community gardens on the west coast (Evergreen Shellfish Club, Henderson Inlet Community Shellfish Farm, Pickleweed Point Community Oyster Farm, Port Madison Community Shellfish Farm) and east coast (Great South Bay Oyster Gardening Program, Three Mile Harbor Shellfish Garden). In most coastal states, oyster restoration programs without an explicit gardening component also provide the means to participate in cultivation practices. A subsequent effect of this model is the provision of access to bivalve gardening to participants without ownership of waterfront property.

19.2.1.3 Training

Many bivalve gardening associations and restoration programs base the process of membership accretion on their educational/training syllabus. In general, educational/training components include biology of the cultured species, ecology of the region and its aquatic realms, restoration principles, aquaculture, water management and quality, and seafood safety (Oesterling and Petrone 2012). Many gardening associations and programs provide a training regimen that is packaged with membership/participation. Participants will typically attend a short lecture series on ecology, aquaculture, and bivalve biology, followed by hands-on training with gardening equipment. Aquaculture extension specialists and marine conservation practitioners generally direct training sessions. In terrestrial horticulture, training programs have been developed to empower engaged gardening leadership through a decentralizing process termed “Master Gardener” (Pittenger and University of California 2015). These “Master Gardeners” are entitled to train and mentor individuals within their locality to cultivate crops in a manner specific to the local ecological conditions with techniques refined to the cultivars. Analogous to the terrestrial mode, groups such as the Tidewater Oyster Gardener’s Association, hosts a “Master Oyster Gardener” program that envelops similar mentor-dissemination principles in the aquatic realm; instructing present and potential gardeners in bivalve husbandry techniques. “Master Oyster Gardeners” are then deployed into the community to host workshops and support gardening activities within

their community. Similar training frameworks are employed in other bivalve gardening programs around the country, where veteran growers guide practical instruction.

19.2.1.4 Permits and Regulation

Bivalve gardening is regulated by state agencies, generally rooted in bivalve sanitation, coastal zone planning, and species restriction (to prevent introduction of invasive species, disease, parasites, etc.). Regulations can vary considerably between states, and applicability can be dependent of personal property law in a given municipality. In accordance with the National Shellfish Sanitation Program (NSSP) Model Ordinance, most states that recognize bivalve gardening activities, govern these activities through permitting and compliance processes. In Virginia, for example, obtaining permission to garden is relatively straightforward; a potential gardener obtains a simple permit from the Marine Resource Commission (MRC). Non-commercial permits (personal consumption) are cost-free, and require specific use constraints, such as avoidance of Submerged Aquatic Vegetation areas, siting to avoid conflict with watercraft and other configuration-specific considerations (4VAC20-336). Some bivalve gardeners pursue permitting to sell their products or use them in a public setting. Additional permits from the MRC are required for sales, depending on the location and physical garden setup; commercial aquaculture operations follow the same regulations. Across the state border, however, in Maryland bivalve gardeners are prohibited from utilizing their oysters for consumption or sale, and must relay them to a restoration site. Gardening activities in Maryland are permitted by the US Army Corps of Engineers under physical and maritime use conditions, and gardeners must register with the state Department of Natural Resources. In New York, a permit is acquired from the state Department of Environmental Conservation, and while personal consumption is encouraged, sale is prohibited without a specific commercial permit.

From the public health realm, regulation of gardening activities is exercised by similar spatial restrictions applied to commercial growers. Taking Virginia again as an example, bivalve growing areas are defined and regularly monitored for algal toxins and human enteric pathogens. When an area is ‘condemned’, growers are prohibited from harvesting regardless of their permit status. These condemnations may be seasonal, and may permit the grower to relocate their bivalve to another area for depuration. Sales of fresh product must first undergo operational inspection from the state Department of Health, which manages regulation on bivalve sanitation. Shucking or further processing/handling of tissue requires rigorous inspection, planning, and a permit from the same department (12VAC5-150).

19.2.1.5 Oysters in New York

Cornell Cooperative Extension (CCE) of Suffolk, New York began an oyster gardening program in 2000 at its Southold facility on the north fork of Long Island. Beginning in 1992, The Suffolk County Marine Environmental Learning Center (SCMELC) used a small bivalve hatchery to assist local townships with bivalve seed that would be grown in gardens, and then broadcast for bivalve restoration and stock enhancement purposes. The bivalve stocks in this area had been heavily compromised by a harmful algal blooms referred to as the "brown tide" (*Aureococcus anophagefferens*). The facilities produce an average of 4–6 million bivalve seed from three species and provide education to the community on a year-round basis. Increased awareness within the community of bivalve and their potential for improving water quality spurred the need for a more comprehensive approach to nurturing the seed in order to boost survival rates, as well as to foster a greater sense of environmental stewardship. Hence, the Suffolk Project in Aquaculture Training (SPAT) was developed and launched following an introductory open house in December of 1999. Table 19.4 summarize the elements of starting and keeping a successful bivalve garden based on the SPAT experience. This program is distinct from the Billion Oyster Project (BOP) as described in DeAngelis et al. 2019. The BOP project is focused on educational training in schools, rather than participation of private persons as in the SPAT project.

SPAT offers membership to the public requiring a yearly fee, providing 1000 oyster seed that can be deployed and harvested for personal use. This was modified from the original approach, which provided 2000 seed and required 50% of the survivors to be broadcast into the environment. For members that have their own private access to water, specific rules apply; including the inability to sell their stock, requisite cultivation in waters that are certified as sanitary, and to acquire the necessary permits. For members who do not own private access to water, three community gardens are available for planting, which are overseen by CCE staff (Fig. 19.1). In 2016, active membership comprised 226 families, 68 of which owned private waterfront; over 1000 families have interacted with SPAT through its tenure.

While oyster gardens and the ability of individuals to culture their own stock for personal use are essential features of SPAT, the strength of the program has resided in aquaculture training. The program hosts weekly volunteer work sessions; on average, members have collectively logged over 10,000 volunteer hours annually. During these work sessions, members become involved in all aspects of the program, included construction of numerous systems such as floating and land-based upwelling systems. Since 2002, SPAT has operated its own bivalve hatchery, the "SPAT Shack" which was built and funded by the members. In 2016, members added a second hatchery system, producing ~1 million oyster seed and 1 million clam seed. As an essential component of the hatchery, a full nursery system is maintained to hold stocks until ready for deployment in the environment.

The "SPAT Shack" provides members the autonomy to learn bivalve culture techniques without ulterior demands. This allows members to study the cultivation

Table 19.4 Elements of starting and keeping a successful shellfish garden

How to get started	The committee concept
Have a clear goal in mind, however small or large.	Division of labour allows for multiple components of the project to be addressed simultaneously and aggressively.
Rectify immediate obstacles (permits, regulations, and local community acceptance).	Utilizing a dedicated core group of volunteers with specific expertise and commitment to a specific component of the project leads to a higher level of quality results.
Solicit some level of funding, however small.	Monthly meetings of the committee chairpersons (advisory board) lends itself to a high level of coordination through solid communication.
Draft a plan of action to achieve the project goals.	Committee chairs network well with the volunteers at large.
Advertise an informal community open house (make sure you invite press and politicians).	A higher level of commitment is necessary from the program coordinator or project group leader in order to maintain coordination.
Follow up with all interested parties.	Involvement of all members
Calendarize some worthy events/ activities.	Priorities must be kept in order for the group to function as a whole.
Delegate important functions to core group.	
Network and develop partnerships.	
Maintain momentum.	
Training sessions	**Facilities and equipment**
Volunteers will understand the process.	Being a turn-key operation takes many years and depends on the various possible site specific constraints.
Volunteers will be learning about techniques that will be used during various phases of a project.	Seed availability is key for starting a sea garden and an operational bottleneck. Hatcheries are expensive and complex to run. Operators say “I wouldn’t wish a shellfish hatchery on my worst enemy...”.
Questions will be answered on topics of interest or importance to the individual and the group as a whole.	Another saying is “be careful what you wish for.” Programs and projects can fall apart by wanting too much too soon.
Confidence and understanding will be gained by the volunteers on the subject matter.	Partnerships with successful operations are always a plus.
Confidence and understanding will be gained by the trainer on how to convey concepts to the group.	Developing a program is like climbing a ladder, taking it one rung at a time (and not looking down)!
The trainer will get to know the individual volunteers.	Be logical, economical and efficient with budgets.
Expertise will be needed by the trainer in the subject matter.	
Commitment will be needed by the program organizers.	
Enables volunteers to become ambassadors for the program.	

Fig. 19.1 Community garden with 50 growers (SPAT – U.S.). (Photo courtesy: Kim Tetrault)

of bivalve seed in a relatively stress free and non-competitive environment. Accessibility to workshop facilities and institutional staff is meaningful to member participation. A year-round lecture series is hosted which includes 11 two-hour lectures offered twice each month covering all aspects of bivalve aquaculture. These lectures are well attended with an average of 35 members per month.

The most essential element of the SPAT program relates to the organisational structure under which it operates. CCE is a non- profit organisation (US, 501- C3) whose primary mandate is to educate members of the community, and assist them in putting their knowledge to work. The marine division of CCE is staffed by marine professionals, providing SPAT full-time oversight from CCE. This dual management system (from members and staff) simultaneously supports the community ownership of the program while maintaining demonstrable standards in its operations.

19.2.2 The Danish Case Study: Food Provisioning, Well-being, and Environmental Awareness

Unlike the U.S., the concept of bivalve gardening in Denmark emerged with the aspiration to empower citizen stewardship on local seafood production for family consumption. Bivalve gardening also aspires to promote a Danish lifestyle of health and well-being. There is a general interest in healthy and organic food and it is also visible in recent movements such as the “New Nordic Cuisine” where Danish chefs

Fig. 19.2 Map of main shellfish gardens in Denmark. Green dots, Fjord garden project, yellow orange and blue independent projects. Red circle indicate the local population size associated to the garden

and citizens are promoting "slow food" by going back to locally grown, wild, healthy and sustainable Scandinavian food delicacies.

Since 2011, several bivalve gardening initiatives have become functional. The concept is expanding in Denmark, culminating in small rural areas ranging from 4000 inhabitants to large cities such as the capital Copenhagen with more than 1.7 million inhabitants (Fig. 19.2). Cultivated species consist of entirely endemic varieties; mussels (*Mytilus edulis*), flat oysters (*Ostrea edulis*), and macroalgae (*Saccharina latissima, Palmaria palmata*). Invasive species such as the Pacific oyster (*Magallena gigas*) are prohibited to be cultivated, hence also in gardens.

Several factors could explain the reasons bivalve gardening in Denmark is flourishing: most of the described constraints to bivalve gardening in Table 19.2 are met:

- **Physical**: Denmark has a long and sheltered coastline. The ratio of land to coastline in Denmark is extremely small (5.8 km^2/km) in comparison to all other bivalve producing European countries (e.g. Norway = 12.1, UK = 19.5, or France = 132 km^2/km, The World Factbook 2017). This geographical-historical feature provides particular access and relationships with the marine environment. Moreover, most sheltered estuaries are quite shallow and protected from large fetch, thus bivalve production infrastructures do not require elevated investment and is easily accessible with a small boat or from structures directly connected to the shore. The conversion of unused industrial harbours to clean areas for new nautical activities is opening easy access space for bivalve gardens, as long as the sanitation is good for growing bivalves.
- **Biological/Ecological**: Good sanitation conditions and high primary productivity make Danish waters very suitable for the aquaculture of filter feeding bivalves. Moreover, production and ecological carrying capacities on basin scales seem far from being realized (Nielsen et al. 2016). Danish waters are highly impacted by eutrophication due to an excess of terrestrial nutrient loading even though there is a mandated policy of reducing nutrients introduction into waterways to comply with EU Water Framework Directive standards (WFD – "Directive 2000/60/EC"). Most coastal areas around Denmark have high hygienic water (Class A areas) thanks to an increasing number of waste waters treatment plants (WWTP, Carstensen et al. 2006) meaning that bivalves can be harvested for direct consumption under the Shellfish Water Directive (2006/113/EC).

Species A key aspect of bivalve gardening is the free access to seed and fast growth of the cultivated animals, which makes it attractive to the gardeners. There is a high level of natural recruitment for local species and it can take less than a year for mussels to reach commercial size in certain areas, such as the Limfjorden. Provided the high natural recruitment of mussels (*Mytilus edulis*), no hatchery are necessary for cultivation. Mussel seed is collected naturally on spat collectors placed in the garden around May, seeds are then sorted and then socked around September, and the crop is harvestable from April the following year. Regarding the native flat oysters (*Ostrea edulis*), spat can be collected from spat collectors deployed in sheltered areas with an existing population of oysters or small oysters can be hand-picked if allowed by the authorities and kept in the gardens for ongrowing. It takes approximately 3 years to reach commercial size in the Limfjorden. A more secure supply of oyster seed would rely on hatchery production, which is expensive and not yet reliable in Denmark.

- **Legal**: The delivery time for a licence can be relatively short in Denmark but depends on the competent authorities and whether there are objections from stakeholders. It normally takes less than 4–5 months to produce a licence; and authorities are considering an easier procedure for sea gardens as long as the production is not commercial due to food sanitation regulation

- **Social and cultural**: New Nordic Cuisine, the slow food movement and connection to the sea are catalysts for the creation of bivalve gardens. Overall, there is a positive acceptance and enthusiasm for sea garden projects by citizenry.

An interesting aspect of bivalve gardening organisations that have developed in Denmark is their different approaches to constitution: (i) One person or a small group of citizens create an association of bivalve gardeners and run it, (ii) A group of citizens or a local agency promote bivalve gardening and create associations together with partners and then recruit citizens and board members to run the association, Most bivalve gardens in Denmark maintain their own informative website often associated to social media such as Facebook. Associations cover an annual fee between 40 and 70 euros and consist of 30–200 members. Associations are generally composed of various groups with key interests such as gourmet foods, aquaculture techniques, art, demonstration of aquaculture practice, food and workshop events, seaweeds, mussels, and oysters. In 2011, a pioneering group of citizens interested in non-commercial seafood production for personal consumption developed the present gardening concept and by 2013, the "Havhaven Ebeltoft Vig" (Sea Garden Ebeltoft Vig) association had created the first hobby-based bivalve garden in Denmark (Fig. 19.2). Their configuration consisted of a few longlines of mussels and seaweed, which are deployed with both common and individual crops. Based on the same principle another association, "Kerteminde Maritime haver" (Kerteminde Maritime gardens), deployed a bivalve farming structure and the first lines and socks of seaweed and mussels in 2016.

In Copenhagen, a non-profit association called "Maritime Nyttehaver" (translated: Maritime allotments) started in 2012. The garden is situated in the middle of the capital harbour, which is now remediated from past polluting industries but not sanitary enough to provide edible bivalves (Fig. 19.2). The main objective of this association is to establish urban aquaculture and promote ocean literacy. Products such as clothing, courses, culture demonstrations, and mussel culture kits (which includes spat collectors, bivalve gardening guide, ropes etc.) for individual use are marketed to help finance the garden operation. These mussel kits could raise some legislation and management concerns regarding their individual use, the deployment location, the potential impact of the material on other users, and ecosystem impacts in the coastal environment beyond deployment.

As another example, Fjord garden project, a large privately funded project in partnership with four municipalities, called "Fjordhaver i Limfjordens havne" (Estuarine gardens in the Limfjord harbour), was launched in 2015. This project enabled the development of four sea gardens in four different harbour cities of the largest Danish estuary (Limfjorden, Fig. 19.2), with the assistance of professional groups to establish the gardens. The development of the sea gardens varied with different constraints at different locations, but employing the same basic principle to create a local association with a maximum of 150–200 members. In less than a year into the project, two of the gardens became operational. The overall purpose of this "Fjord garden" project is to create opportunities for a "good life" in cities around the Limfjorden. As such, the project is driven by five core beliefs: (1) create

life in depopulated or unused port areas and provide space for social activities to interested and committed citizens; (2) bring "blue" into the city; (3) empower non-professionals in relation to seafood production to facilitate understanding of the production process and creating a relationship between the product and the educated consumer; (4) promote healthy meals and lifestyles with roots in the local maritime history; and (5) increase ocean literacy to further develop roots in the sea and raise local awareness of the goods and services provided by organic and inorganic extractive aquaculture species (bivalve and macroalgae respectively) as opposed to the fed species (e.g. finfish).

Several workshops have been conducted throughout the Fjord garden project, gathering all members of the 4 associations and including professionals in order to train members and transfer knowledge for the sustainability and legacy of the bivalve gardens beyond the project life (end 2017). Workshops address training on mussel, oyster and seaweed production, food safety, ecology of the fjord, biology and growth cycle for year-round production, garden setup and production material (e.g. knots, buoys, socks, longline setup, boat and platform operation), and finally how to handle the harvested product including preparation. Food safety and culinary workshops have been evaluated has very important by the association members. Project members have participated in the establishment of gardens (Fig. 19.3) on two different types of production structures: long-line configurations accessible by boats, and rafts connected to land (Fig. 19.4). In some associations, subgroups have emerged to specialise in the cultivated species, or boat and structure maintenance. In less than 2 years of their creation, the associations and gardens have already garnered more than 200 members in total, sharing a common interest. Thus far, the relative success of the bivalve sea gardens can be attributed to positive dissemination from local media, distribution of promotional leaflets, professional and financial support from the private fund Nordea and most importantly, motivated and committed members. Challenges however may arise as the project ends in regards to the professional and financial support for the legacy in training of new members and maintenance of facilities and equipment. To stimulate project legacy, a sea garden guide with key information gathered during the project will be produced.

There are several additional challenges to the future development of bivalve gardens in Denmark. In certain areas, predators such as Eider ducks (*Somateria mollissima*) can feed on and eliminate an entire production unit of hanging mussels. In terms of food safety, analyses for water quality are extremely expensive and not carried out by the authorities, but rather by the users. The Danish Veterinary and Food administration from the Ministry of Food and Environment of Denmark has some clear guidelines for private harvesting of mussels and oysters regarding bivalve sanitation: there is no imposed restriction in consuming bivalves from bivalve gardens as long as it is for private use and not sold (update from the 01/09/2018 https://www.foedevarestyrelsen.dk/Selvbetjening/Guides/Kend_kemien/Sider/Indsamling-af-muslinger-og-oesters-mm-hvad-skal-man-vaere-opmaerksom-paa.aspx). Danish coastal waters are divided into production areas, which are by default closed for commercial bivalve harvesting. In order to open an area for harvest, professionals, either from fishery or aquaculture must conduct

Fig. 19.3 Shellfish garden members participate in the line preparation (**a**), sorting (b), socking (**c**) and hanging of mussel socks on both from the Fjord garden project longline and raft (**d** and **e** respectively) (Denmark). (Photo courtesy Carsten Fomsgaard (**a**–**d**), Rikke Frandsen (**e**))

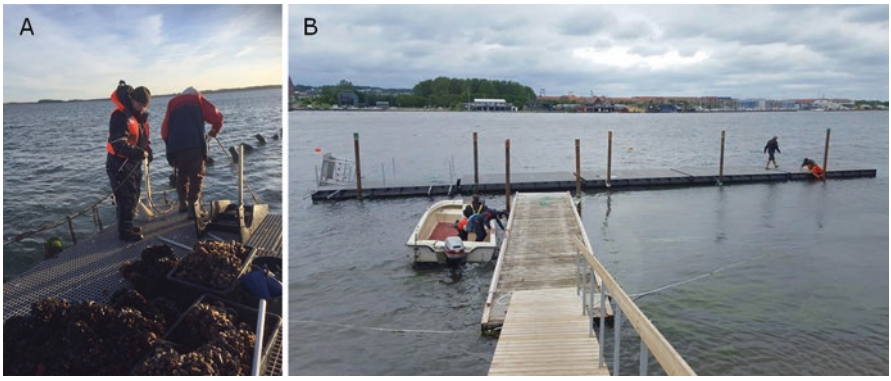

Fig. 19.4 Two different type of production structure: (**a**) longlines area delimited with yellow corner buoys with access by boat and raft used in the Fjord garden project maintenance, and (**b**) raft connected to land (Denmark). (Photo courtesy of Lola Thomsen (**a**) and Esge Hansen (**b**))

microbiological, toxicological (algae) and chemical contaminants analysis on fresh bivalves and water samples from the area. Responsible consumption is therefore advised for both hand-picked bivalves, and bivalve gardeners, whom can benefit from the analyses conducted by professional producers in the same areas.

Although the issue of competition between bivalve gardeners and commercial operators can be problematic, it is marginal due to: (i) the small volume of bivalves produced by e gardens, (ii) the non-commercial definition of bivalve gardens, (iii) the limited domestic market for bivalves in Denmark and (iv) the interest in bivalve consumption by gardeners could be beneficial on the long term to commercial entities. Presently the cohabitation of gardeners and commercial entities is peaceful as there is no conflict of interest for the use of the coastal area or resources. However, commercial entities are concerned that irresponsible consumption by bivalve gardeners regarding food sanitation could tarnish their image.

In terms of marine spatial planning and social acceptance, overall, bivalve gardens in Denmark as well as bivalve aquaculture are relatively well accepted. The visual pollution from buoys is relatively discrete, but complaints of nuisance linked to buoys washed ashore or other conflicts over use of the space, emerge and delay licencing. Notwithstanding, the keen enthusiasm and interest of Danish citizens in bivalve gardening has resulted in a boom of applications for garden licences around the country; at a rate that the aquaculture administration authorities might have problems to handle, not least in view of the emerging mixed forms of sea gardens, e.g. gardens linked to local restaurants thereby compromising both food safety regulations and undue competition with the professional. This could create, in the long run, the occurrence of unregulated individual gardens with a loss of community and social acceptance and a potential danger for other nautical activities (i.e., if culture equipment is placed in coastal areas illegally). Other issues and potential risks exist for future gardeners and the ecosystem. Bivalve gardens are not protected from potential invasive species or translocation of disease from contaminated seeds, if poor practices are exercised in surrounding waters. Pollution, climate change, and low spatfall are also risks to be taken into consideration. The next logical step, as for bivalve aquaculture, is to monitor the environmental impacts of gardens.

19.3 Successful Bivalve Gardens and Future Challenges

As a phenomenon emerging from socially and culturally instructed objectives in sustainable food production and ecology, bivalve gardening is principally an activity that enhances personal experience and community engagement. The provision of seafood for coastal communities is more profound than the fulfilment of nutrition requirements. Gardening gives agency to individuals and communities to play a role in shaping their food system. While seafood can be a very important source of particular fatty acids and minerals (McManus and Newton 2011), bivalve gardening tends not to be an exercise in securing food; it is an embodiment of cultural-ecological principles that align with contemporary ideology of sustainable food

systems (Turner 2011). Gardens do not compete with commercial food production; they are an expression of ambitions for greater control of food systems, increased variety in the access to nutritious and sustainable foods.

The case studies describe multiple approaches to bivalve gardening, which can manifest at the individual or group-level (Table 19.3). Bivalve gardeners tend to be motivated by interests in preserving or celebrating cultural and place-based heritage, exercising the motions of self-sustenance and self-determination, as well as altruistic dispositions to improve the environment (Krasny et al. 2014). These motivations can be grounded in historical contexts, such that gardening can provide the means to revitalize tradition, the shift from fishing/hand picking tradition to controlled and sustainable hobby aquaculture, and thus form continuity within a community, and across generations. Ecological consciousness and a drive to take part in processes governing the state of physical surroundings and daily life can develop simultaneous self and collective inclinations of discovery. While the impetus for gardening may originate from different sources between case studies, there are common driving factors for bivalve gardeners that are worth describing.

From a culinary perspective, gardening for consumption exhibits its own discernible motives, accompanied by a deeper appreciation for quality aspects of seafood. In some contexts, bivalve gardening can provide easier access to high-value species that may not be a part of the general food culture. As a hobby, there is emphasis on uniqueness of the product and process, where place and husbandry evoke distinct organoleptic characteristics and values attune to being ‘home grown’. Bivalve harvests from the garden for personal consumption are often associated with social gathering. To these effects, bivalve gardening serves an interesting purpose in the expression of cultural and societal values.

In practically every example of bivalve gardening, the desire to learn and educate others about marine ecology, food production, and bivalve biology is strongly expressed. As a physical activity in the outdoors, many participants are drawn to the essence of a structured endeavour that contributes to personal well-being and adds meaning to daily life.

With growing awareness of anthropogenic impacts on aquatic ecosystems and recognition of cultural heritage related to those ecosystems, wide scale interest in mechanisms to positively influence the coastal environment gives rise to organized gardening programs. Restoration of bivalve populations and habitat attracts proponents of environmental stewardship; bivalve gardening provides space for individual ownership of this process (Torres et al. 2017).

The process of establishing bivalve gardens is strongly dependent on sociocultural contexts, such as seafood consumption patterns, environmental awareness, historical perceptions of seafood, social capital, and motivated organizers. Institutional and regulatory frameworks also shape the environment which gardening modes may materialize, such as land tenure regimes and regulation (or the lack thereof). For example, as in the U.S. and Danish cases, the right to deploy a garden in coastal waters can be restricted to shoreline owners or gained through the aquaculture administration authorities and a public arbitration process which may delay licencing. As such, community-based organization is advantageous in acquiring rights to

use coastal waters. Bivalve community gardens could learn from well-established terrestrial community gardens and the various toolkits already in place. One of the most important core beliefs in this paradigm is the grassroots approach, where citizens are engaged from the instigation through the operation of the community garden and empowered through stewardship of the food production (Abi-Nader et al. 2001).

As participation in bivalve gardening initiatives expands, present and future challenges will be confronted. Presently, food safety is the immediate concern for public health and the seafood industry. Years of refinement in harvesting techniques and food safety practice (i.e. HACCP) have contributed to the growth of the bivalve industry and subsequent growth in demand for fresh bivalves. In addition to the direct public health impact, disease outbreaks related to unsanitary practices can be damaging to gardening programs and the bivalve industry. With the emerging issues of climate change, invasive species and connectivity between bodies of water (i.e. translocation of seed, ballast), vectors for HABs and pathogens are increasing (Tirado et al. 2010). The regular monitoring for water quality and bivalve contamination is a necessity to guaranty public health. However, certified analyses remain costly and slow and often not affordable for gardeners when the garden does not belong to an area monitored by the state or the industry. The development of new technology (e.g. molecular, genetic) for quicker and more affordable test kits seems inevitable for bivalve gardening.

Analogous to terrestrial gardens, bivalve gardens require space, which can be limited and contentious; particularly in coastal waters where Marine Spatial Planning is confronted with the dilemma of achieving potentially antagonistic goals between good ecological status and economic development of blue growth (Jones et al. 2016). There are a number of common issues that arise counter to the development of coastal aquaculture, including habitat manipulation from fixed structures or working equipment, interference with other recreational uses of the same waters, and aesthetic impacts. Gardening efforts should balance stakeholder perceptions and remain receptive to the community, which hosts the garden.

While bivalve gardening is ordinarily described as an environmentally and socially positive activity, there are circumstances in which gardening could impart negative consequences. The marine environment, as a medium for the growth of gardened species, contrasts with terrestrial gardens in the risk potential for spread of pathogens and invasive species. Indeed, while common stewardship of our land resources in this light should be a broad objective, the marine environment cannot be discretized in a controlled manner. Poor gardening practices, such as haphazard seed sourcing and transfer of organisms between distinct coastal waters, can be catastrophic to local ecology and industry. Conforming to the roots of gardening, strong mentorship is exceedingly important to realize gardening goals and ensure sustainability of its practices. Although in areas such as Denmark where gardens are localised in eutrophic areas where phytoplankton is in excess, the cultivated bivalves do not compete with native wild species, ecological carrying capacity should be considered in the establishment criteria of a garden (Table 19.2).

Within the regulatory framework of many regions, countries, municipalities, and towns, bivalve gardening is often a novel concept with peculiar aspects that may

present difficulties in formulating effective regulation. Guiding sustainable gardening practices through regulation should reflect the aforementioned potential problems with gardening, however, doing so may culminate in unwieldy rules that overburden gardening programs; especially while balancing other stakeholder interests. Leaders in the gardening community should reach out to regulators and policy makers to help advise the formulation of regulations.

The longevity and legacy of gardening initiatives can often be overlooked. Accretion of younger generations participating with similar levels of enthusiasm can prove to be very difficult for some groups, particularly in restoration programs. As many gardening efforts are founded in cultural heritage and the motivation to revitalize that heritage, gardeners working in community-based programs should carefully contemplate and plan for conceptual inheritance of bivalve gardening.

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