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REVIEW

Toward a decade of ocean science for sustainable development through acoustic animal tracking

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Abstract

The ocean is a key component of the Earth's dynamics, providing a great variety of ecosystem services to humans. Yet, human activities are globally changing its structure and major components, including marine biodiversity. In this context, the United Nations has proclaimed a Decade of Ocean Science for Sustainable Development to tackle the scientific challenges necessary for a sustainable use of the ocean by means of the Sustainable Development Goal 14 (SDG14). Here, we review how Acoustic animal Tracking, a widely distributed methodology of tracking marine biodiversity with electronic devices, can provide a roadmap for implementing the major Actions to achieve the SDG14. We show that acoustic tracking can be used to reduce and monitor the effects of marine pollution including noise, light, and plastic pollution. Acoustic tracking can be effectively used to monitor the responses of marine biodiversity to human-made infrastructures and habitat restoration, as well as to determine the effects of hypoxia, ocean warming, and acidification. Acoustic tracking has been historically used to inform fisheries management, the design of marine protected areas, and the detection of essential habitats, rendering this technique particularly attractive to achieve the sustainable fishing and spatial protection target goals of the SDG14. Finally, acoustic tracking can contribute to end illegal, unreported, and unregulated fishing by providing tools to monitor marine biodiversity against poachers and promote the development of Small Islands Developing States and developing countries. To fully benefit from acoustic tracking supporting the SDG14 Targets, trans-boundary collaborative efforts through tracking networks are required to promote ocean information sharing and ocean literacy. We therefore propose acoustic tracking and tracking networks as relevant contributors to tackle the scientific challenges that are necessary for a sustainable use of the ocean promoted by the United Nations.

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acoustic tracking, climate change, fisheries, marine pollution, movement, networks, ocean monitoring, sustainable development, telemetry

1 | INTRODUCTION

The ocean is a key component of the Earth's dynamics and provides a great variety of ecosystem services (Barbier, 2017). Oceans and seas produce up to 16% of the animal protein used for human consumption and provides to approximately 3.3 billion people with almost 20% of their average per capita intake of animal protein (Duarte et al., 2009; Edwards et al., 2019; FAO, 2021). It is projected that oceans could generate food for almost 10 billion people by 2050 if managed in a sustainable way (Costello et al., 2020). However, human activity is drastically changing the structure and functioning of oceans, generating the ethical obligation to rebuild marine biodiversity and preserve the many benefits that society receives from a healthy ocean (Duarte et al., 2020).

In this context, the United Nations has promoted the "Decade of Ocean Sciences for Sustainable Development (2021–2030)" (UN, 2015). This initiative is mainly focused on tackling the scientific objectives that are necessary for a sustainable use of natural resources (summarized in Ryabinin et al., 2019). Within this decade, the UN expects to encourage the scientific community, managers, non-governmental organizations (NGOs), policy-makers, as well as the general public to move beyond "business as usual" and aspire to a real social and economic change (Claudet et al., 2020), based on decision making informed by scientific criteria (Pendleton et al., 2020). The objectives to be tackled in the Decade of Ocean Sciences for Sustainable Development are described as the UN Sustainable Development Goals (SDGs), specifically within the SDG14, which refers to Life Below Water (https://sustainabledevelopment.un.org/sdg14). The Sustainable Development Goal SDG14 aims to preserve marine biodiversity and shift toward the sustainable use of oceans, seas and marine resources by following specific targets driven by scientifically informed managerial decisions (Figure 1).

During the last decades, ocean science has made great progress enhancing our ability to predict changes in marine ecosystems. However, we still do not fully understand the magnitude of the current problems and the best way to implement effective solutions based on scientific data (Laffoley et al., 2020). Measuring the responses of marine ecosystems to a changing ocean can be particularly challenging in remote habitats such as polar regions, the deep-sea, or the high-seas (Howell et al., 2021; Kennicutt et al., 2014). To that end, animal biotelemetry, or the use of electronic devices to remotely measure the physiology, behavior, or energetic status of free-living animals (Cooke et al., 2004), has been proven useful to provide with information from these uncharted waters (Sequeira et al., 2018). Biotelemetry is a commonly applied method to investigate the movement ecology and behavior of marine fauna in relation to their environment. It has provided a scientific basis for management and conservation (Hays et al., 2019) and has significantly improved our understanding of the ecosystem functioning and dynamics (Katzner & Arlettaz, 2020; Lennox et al., 2017).

Among the different available biotelemetry techniques, Acoustic animal Tracking (AT) is the most widely used in free-living marine organisms (Hussey et al., 2015; Matley et al., 2022). In fact, AT has traditionally produced scientific information to inform sustainable use of the oceans (e.g., Crossin et al., 2017; Friess et al., 2021; Lowerre-Barbieri et al., 2021). In AT studies, organisms are typically equipped with transmitters that emit an ID coded acoustic signal at specific frequencies, which is then detected by arrays or gates of acoustic receivers (Heupel et al., 2006). In addition, the transmitters can incorporate specific sensors measuring environmental variables (e.g., temperature), movement, and behavioral traits (e.g., depth, acceleration, and predation events; Thorstad et al., 2013). These sensors allow to directly link the animal's behavior (3D movement and space-use) to the surrounding environmental conditions, providing a technology to continuously monitor not only the distribution of marine biodiversity *per se* but

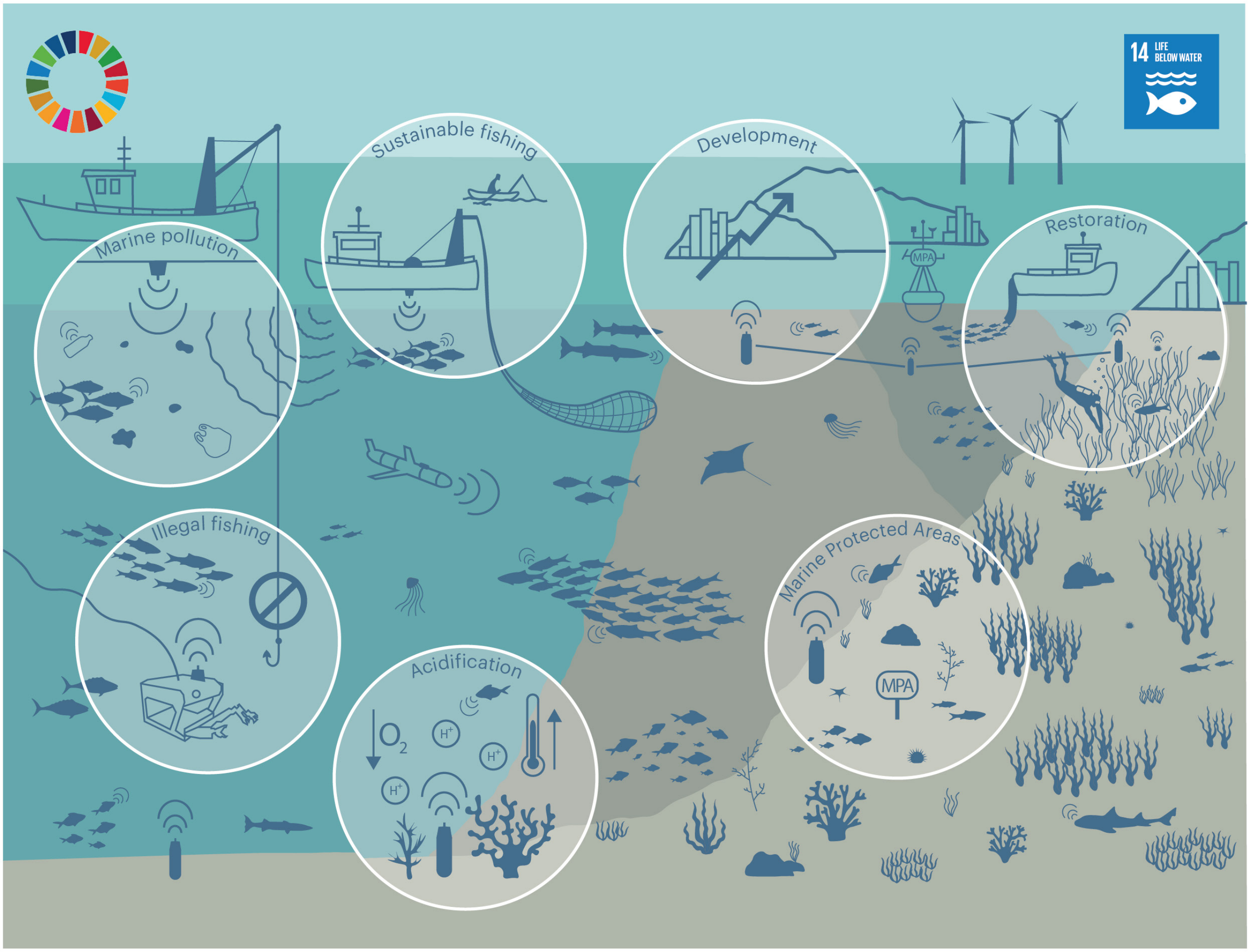

FIGURE 1 Toward a Decade of Ocean Science for Sustainable Development of Marine Biodiversity Using Acoustic animal Tracking (AT). The SDG14 identifies ten targets to create action to conserve and sustainably use the ocean: Target 14.1 reduce marine pollution; Target 14.2 protect and restore ecosystems; Target 14.3 reduce ocean acidification; Target 14.4 conserve coastal and marine areas; Target 14.5 sustainable fisheries; 14.6 end subsidies contributing to overfishing, illegal, unreported, and unregulated fishing; Target 14.7 increase the economic benefits to Small Island Developing States and least developed countries; Target 14.A increase scientific knowledge, research and technology for ocean health; Target 14.B support small-scale fishers; and Target 14.C implement and enforce international sea law. This review provides a list of specific examples in how AT can help reaching these targets by providing cutting-edge scientific data.

also the changing environmental conditions (Aspillaga et al., 2017). In addition, the relatively low cost of electronic tags, their extended life span (over 10 years), the ability of arrays of receivers to generate high-throughput accurate positional data (Nathan et al., 2022), and the possibility to monitor large numbers of individuals without the need of recapture (Aspillaga et al., 2021), make AT a promising tool to generate high-quality scientific data to address the major targets proposed by the SDG14.

The objective of this work is to review case-studies that show how AT and Tracking Networks of acoustic receivers (TN) can be used to provide with a roadmap for implementing and achieving the SDG14 targets by 2030 (Figure 1). In the following sections, we list target-by-target empirical examples and discuss how AT and TN can contribute to the task of providing high-quality scientific outputs to design optimal strategies for the sustainable use of oceans and rebuilding marine biodiversity.

2 | SDG14 TARGET 1—ACOUSTIC TRACKING TO MEASURE THE EFFECTS OF MARINE POLLUTION

Pollution is present in all aquatic ecosystems as a result of deliberate or accidental disturbances such as discharges from industry and agriculture, noise, artificial lighting, and dumping of solid waste (Barnes et al., 2009; Carpenter et al., 1998; Duarte et al., 2021; Larsson et al., 2007; Longcore & Rich, 2004). The first SDG14 target aims to significantly reduce marine pollution by 2030. The effects of pollutants on marine animals have been mainly studied in laboratory-based settings (Carlsson et al., 2009; de Jong et al., 2018; Kasumyan, 2001). However, the results from such experiments can seldom be directly extrapolated to complex wild ecosystems (Bertram et al., 2022; Calisi & Bentley, 2009). Using AT, behavioral data can be directly obtained from a wild population while measuring other environmental variables such as pollution levels (Barcelo-Serra et al., 2021). In this way, it is possible to assess the direct effects of pollution on animal behavior and welfare (Hellström et al., 2016; Huveneers et al., 2021).

Chemical water pollutants such as pesticides, fertilizers, heavy metals, and drugs have a great impact on aquatic wildlife (Kasumyan, 2001; Pyle & Ford, 2017; Sanchez et al., 2011). These pollutants, even in small concentrations can lead to biodiversity loss and pose a threat to human health via ingestion of harmful chemicals bioaccumulated in aquatic organisms. Studies using AT have assessed the effects of chemical pollution on fish mortality (Thorstad et al., 2013), habitat use (Burns et al., 2021; Crear et al., 2016; Curtis et al., 2013; Madrak et al., 2016; Moser & Lindley, 2007), and on species captured for human consumption (O'Toole et al., 2012; Taylor, van der Meulen, et al., 2018). The results of such studies show the broad applications of AT for the preservation of aquatic fauna and to ensure safe marine-derived products for human consumption.

Chemical and oil spills as a result of industrial accidents lead to mass mortality events and long-lasting environmental perturbations (Munilla et al., 2011; Peterson, 2003). In the event of such catastrophic incidents, having baseline information on the previous ecosystem functioning, including environmental and animal movement data, is of utmost importance for restoration plans (Bjorndal et al., 2011; Peterson, 2003). For instance, the movements of marine fauna before, during, and after oil spills have been monitored using AT, showing important short- and long-term effects on physiology, behavior, and survival (Vander Zanden et al., 2016; Zięba et al., 2014). It follows that having TNs deployed in areas susceptible to pollution can provide valuable insight on animal behavioral changes in the event of chemical accidents or global crises.

Activities such as seismic surveys, mining, commercial and recreational shipping, and intense urbanization are the most important sources of anthropogenic noise and artificial lighting oceanwide (Estabrook et al., 2016; Hildebrand, 2016; Longcore & Rich, 2004). Exposure to high levels or long periods of noise has a negative impact on marine animals, resulting in hearing capacity losses, physiological, and behavioral alterations (Cox et al., 2018; Fewtrell & McCauley, 2012; Rolland et al., 2012; Simpson et al., 2016). Furthermore, the continuous presence of artificial light can compromise orientation during the hatchling dispersal of sea turtles (Salmon et al., 1995). Measuring the effects of these disturbances on aquatic animal behavior has been impaired by the lack of appropriate tools (Barcelo-Serra et al., 2021). However, recent AT studies managed to reveal significant impacts of seismic surveys (Figure 2), shipping, and wind farm noise on fish behavioral patterns (Davidsen et al., 2019; Ivanova et al., 2020; Rider et al., 2021; Wardle et al., 2001; Winter et al., 2010) and potential effects on population survival and fisheries productivity (Bruce et al., 2018; Hubert et al., 2020; van der Knaap et al., 2021, 2022). The benefits of AT to measure the effects of light pollution is extended to other no-fish taxa. For instance, Thums et al. (2016) and Wilson et al. (2018) also showed that, in the presence of artificial lights, turtle hatchlings alter their movement trajectories reducing hatchling survival. Given that an increase in coastal development and ocean-based industrial activities is expected in the next decade, technologies such as AT can be used to inform strict regulations to manage the negative effects of these types of emergent pollutants (Duarte et al., 2021; Nowacek et al., 2015).

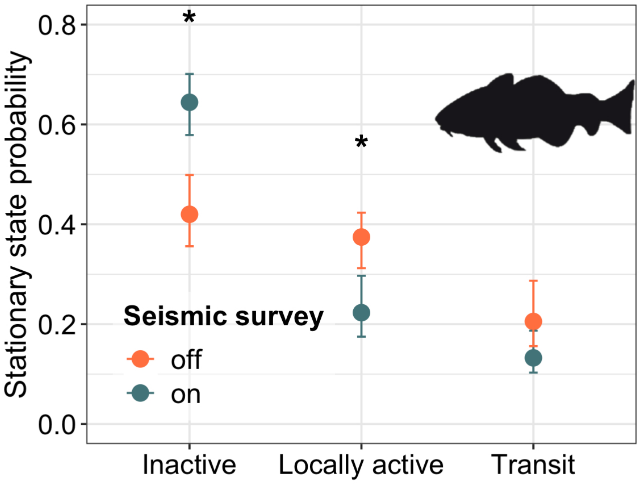

FIGURE 2 Acoustic animal Tracking (AT) can be used as a tool to measure the effects of noise pollution on fish behavior. This plot shows the results of an AT experiment on Atlantic cod *Gadus morhua* showing the effects of a seismic survey on the probability of switching between different activity states (adapted from van der Knaap et al., 2021).

Finally, the uncontrolled dumping of solid waste is filling our oceans with debris, mainly from single-use plastics and litter from industrial activities such as lost fishing gear (Barnes et al., 2009; Consoli et al., 2018; Li et al., 2016). Overall, over 150 million tons of plastic have now accumulated in the oceans, with 4.6–12.7 million tons added every year (Jambeck et al., 2015). There is also mounting evidence that this pollution is even reaching the deep-sea, with surprisingly high quantities being accumulated in the sea bottom, from continental slopes to abyssal plains (Chiba et al., 2018). Given these overwhelming numbers, removing debris from the oceans seems unfeasible. However, tracking plastics with AT could help to elucidate the routes followed by debris from land into the sea (Duncan et al., 2020), including the open ocean and the deep-sea, and thus critically inform localized management actions with a reverberating effect in the wider ocean (Bert et al., 2021).

3 | SDG14 TARGET 2—ACOUSTIC TRACKING AS A TOOL FOR OCEAN PROTECTION AND RESTORATION

The second target of SDG14 aims to sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, strengthen their resilience, and act on their restoration. While marine protected areas (MPAs) are addressed by SDG14 Target 5, effective protection plans from widespread human activities and site-specific developments that impact marine ecosystem health and biodiversity are also required. Monitoring the effects of protection and restoration of the oceans requires deep insight into the habitat use and migrations of often highly mobile aquatic animals. Such information can now be gathered using AT to inform spatial management plans, identify essential habitats, perform environmental risk assessments, or assess the impacts on marine biodiversity before and after the construction of infrastructures. For example, AT has been successfully employed to detect the behavioral impacts of shipping (Ivanova et al., 2020; Sertlek et al., 2019), dredging (Castro-Santos et al., 2019; Wenger et al., 2017) and seismic surveys (Slabbekoorn et al., 2019; van der Knaap et al., 2021, 2022), identifying management and policy implications. Therefore, this tool should be widely promoted given the undergoing or planned expansion of blue economy marine infrastructures, namely renewable energy infrastructures and deep-sea mining, respectively, both of which may have confirmed or suspected severe impacts (Masmitja et al., 2020).

Harvesting renewable energy from winds, currents, tides, and waves is a relatively new threat to marine ecosystems (Gill et al., 2020) and there are significant concerns on its environmental impact and sustainability (Dannheim et al., 2020). For example, wind turbines and power cables can impact marine ecosystems during construction (e.g., pile driving) and operation, introduce artificial physical infrastructure to the ocean, alter the water currents, and emit electromagnetic fields, along with elevated vessel traffic (Boehlert & Gill, 2010; Degraer et al., 2020; Gill, 2005). Using AT, we can gather pre-development baseline spatiotemporal animal movement data. In fact, Ingram et al. (2019) suggested that AT should be a prerequisite to evaluate the impact of an offshore wind energy development to mitigate its potential negative impacts on the endangered Atlantic sturgeon, *Acipenser oxyrinchus*. Once constructed, human-made infrastructures can also provide physical habitat for fish aggregation, influencing local biodiversity and ecosystem functioning (Halouani et al., 2020). Reubens et al. (2013, 2014) used AT and stomach content analysis to identify a seasonal preference to wind farms related to feeding but also shelter from currents and predators in a commercially important fish in the North Sea. Staines et al. (2019) showed that AT can produce high-resolution movement data required to assess potential lethal interactions of fish with tidal turbines. Finally, Everett et al. (2020) used AT to assess the seasonal patterns of area use in northern red snapper, *Lutjanus campechanus*, to schedule the explosive removals of decommissioned platforms as to reduce impacts.

Coastal ecosystems around the world have suffered habitat loss due to urbanisation, agricultural practices, and infrastructural developments. AT can be used to gather individual- and population-level knowledge on habitat use to inform habitat restoration plans and evaluate their success. For example, AT has been used to assess the functionality of artificial (Arendt et al., 2001; Eggers et al., 2015; Hindell, 2007) and restored (Espinoza et al., 2011; Farrugia et al., 2011; Jirik & Lowe, 2012) estuarine habitats. Freedman et al. (2015) established the connectivity of two discrete restored estuaries based on feeding guild, while TinHan et al. (2018) combined non-lethal natural tracers of trophic ecology with AT to demonstrate how restored oyster reef habitat primarily benefit larger spotted seatrout, *Cynoscion nebulosus*.

Artificial reefs have been used for a long time for habitat protection and restoration purposes (Addis et al., 2013; Bombace, 1989; Clark et al., 1974; FAO, 2015). The extent to which species use artificial reefs as alternative habitats has frequently been determined by AT, bringing new information on site fidelity, home range, habitat use, and diel migration in fish species (Abecasis, Afonso, et al., 2013; Abecasis, Bentes, et al., 2013; D'Anna et al., 2011; Kristensen et al., 2017; Özgül et al., 2015; Piraino & Szedlmayer, 2014; Reynolds et al., 2010; Smith et al., 1999; Taylor, Becker, & Lowry, 2018; Topping & Szedlmayer, 2011). Additionally, AT has been employed to study connectivity and behavioral variation between species using natural and artificial reefs (Abecasis, Afonso, et al., 2013; Abecasis, Bentes, et al., 2013; Getz & Kline, 2019; Koeck et al., 2013; Logan & Lowe, 2018), residency patterns (Keller et al., 2017), interactions between species (Dahl & Patterson, 2020), and exploitation dynamics (Pioch et al., 2011). AT data on exploited reef fishes have also been used to define spatial fishing restrictions and increase fishing efficiency (e.g., Özgül et al., 2019; Topping & Szedlmayer, 2011).

Fish stock enhancement and re-introduction are other important management and restoration measures in response to local stock depletion. For that purpose, understanding post-release dynamics is key to maximize the effectiveness of stocking programmes (Taylor et al., 2017). Thus, the survival, site fidelity vs. emigration dynamics, and habitat selection of stocked (released) fishes have been studied using AT to measure performance of release locations (Pursche et al., 2014), stocking density (Taylor et al., 2013), and shelter acclimation (Kawabata et al., 2011). Captive bred fish can behave unnaturally in the wild due to genetic differences (local adaptation of stocks), domestication (rearing environments influencing development and learning), and acclimation to the new environment. Consequently, stocked fish movements have frequently been compared with wild fish movements using AT such as for seaward migrating anadromous salmonids (Aarestrup et al., 2014; Chittenden et al., 2008; Flávio et al., 2019; Urke et al., 2013) and marine fish (Kawabata et al., 2007; Parrish et al., 2015), including sharks (Lee et al., 2015).

4 | SDG14 TARGET 3—ACOUSTIC TRACKING TO MONITOR THE EFFECTS OF CLIMATE CHANGE

It is now increasingly evident that human-induced global change is profoundly affecting marine ecosystems (Nagelkerken & Connell, 2015; Poloczanska et al., 2013). The global ocean has absorbed ~90% of the excess heat from the climatic system and ~30% of the released CO_2, steadily becoming warmer and more acidic (IPCC, 2019). In addition, oxygen concentrations have concomitantly decreased in coastal waters and beyond due to temperature increases and changes in the ventilation and biogeochemistry of the water masses (Andrews et al., 2013; Breitburg et al., 2018). One of the most evident impacts is the poleward shift in the distribution of many species due to global warming (Hazen et al., 2012; Montero-Serra et al., 2015), yet comparatively there is still much ongoing discussion regarding the effects of ocean acidification on marine biodiversity (Clements et al., 2020). Despite physiological studies having demonstrated that acidification might affect their sensory system (Simpson et al., 2011) and increase larval mortality by predation (Munday et al., 2010), some reviews have not found evidence that fishes are being negatively affected by ocean acidification *per se* (Clark et al., 2020; Kroeker et al., 2013). Nevertheless, acute behavioral changes can be expected due to habitat change forced by decreases in pH (Nagelkerken et al., 2016). The reduction of oceanic dissolved oxygen is also thought to exacerbate the effects of warming and acidification by reducing the physiological tolerance ranges of fishes and other organisms (Deutsch et al., 2015; Pörtner & Knust, 2007).

All climate predictions forecast a worsening of the described conditions in the future (IPCC, 2019) and, consequently, the impacts of global change are also targeted by SDG14. Target 3 of the SDG14 aims to minimize and address the impacts of ocean acidification through enhanced scientific cooperation at all levels. Since ocean acidification is known to generate synergistic effects with warming and deoxygenation, all of them should be considered to safeguard the sustainable use of the oceans and marine resources in the future. Biologging technologies, such as AT, are a key tool to upscale physiological and behavioral studies in the wild (Cooke et al., 2016; Hellström et al., 2016). By using transmitters equipped with sensors (e.g., depth, temperature, acceleration) in combination with continuous environmental data monitoring, AT can be used to explore the behavioral responses of animals to fluctuating environments. These studies provide complementary information to physiological studies in the laboratory on the real impact of environmental changes in an integrative manner.

The most common examples of using AT to unveil the effects of environmental conditions on aquatic animal behavior are thermal preference studies in environments with sharp thermal gradients, such as seasonal thermoclines. These studies allowed to describe a regional or vertical preference for warm waters in many predators, from yellowfin tuna *Thunnus albacares* (Block et al., 1997) to common dentex *Dentex dentex* (Aspillaga et al., 2017), while other coastal species have shown preferences for colder waters, such as Atlantic cod *Gadus morhua* (Freitas et al., 2016), brown trout *Salmo trutta* (Kristensen et al., 2018), or dogfish *Scyliorhinus canicula* (Sims et al., 2006). The few studies using AT to look at the temperature envelopes of deep-sea fishes have shown that in their natal regions, they typically restrict their habitat use to the cold waters below the thermocline, whether they are sedentary residents like rockfishes *Sebastes* (Starr et al., 2002) or perform daily vertical migrations of hundreds of meters such as the blackspot seabream *Pagellus bogaraveo* on seamounts of the mid-Atlantic ridge (Afonso et al., 2012). Similarly, AT has been used to study he effect of oxygen concentration in space use patterns of aquatic organisms. Itakura et al. (2021) described a wide thermal tolerance for the stripped seabass *Morone saxatilis*, that actively avoided both high temperatures and bottom hypoxic waters during summer. Similarly, hypoxic upwelling events caused a 33% reduction in the home range size of the copper rockfish *Sebastes caurinus* (Rankin et al., 2013). All these studies provided key baseline information on the optimal environmental conditions of the studied species, which is highly useful to understand and predict their present and future population trends.

To date, there are no studies directly relating animal behavior and ocean acidification, primarily due to the difficulty that entails conducting continuous pH measurements in the natural environment at relevant scales and the current lack of strong evidences of long-term acidification effects on fishes. However, acute pH gradients, for example, at natural CO_2 vents, are known to generate strong changes in the local benthic communities (e.g., Hall-Spencer et al., 2008; Linares et al., 2015). These areas consist of ideal natural laboratories where the direct and indirect effects (i.e., via habitat shifts) of ocean acidification on the activity, foraging, or space use patterns of species could be studied using AT, especially involving susceptible mobile species such as crustaceans with calcified shells. The fact that these are typically located at deep-sea, remote environments makes it challenging yet holding promise for much discovery, being the use of autonomous vehicles to track tagged species in deep-water constitutes to be a promising advance (Masmitja et al., 2020).

5 | SDG14 TARGET 4—ACHIEVING SUSTAINABLE GLOBAL FISHERIES THROUGH ACOUSTIC TRACKING

Humans have exploited marine animals by way of fishing since the origin of our species (Walters & Martell, 2005). Because marine biodiversity features high in our society's demand for food and recreation, many fish stocks have been overexploited (FAO, 2021). However, many assessed stocks have shown signs of recovery and sustainable exploitation in response to the implementation of proper management regimes (Hilborn et al., 2021). In fact, marine-derived products could feed more than 10 billion people by 2050 contingent to policy reforms, technological innovations, and the societal growing demands toward sustainable exploitation (Costello et al., 2020). Target 4 of the SDG14 aims to effectively regulate exploitation, end overfishing, and implement science-based management plans to restore marine fish stocks at least to maximum sustainable yield (MSY) levels in the shortest feasible time.

There are four major aspects underpinning sustainability in fisheries management where AT can contribute by means of high-quality scientific data (Crossin et al., 2017; Lowerre-Barbieri et al., 2019): allowing a more accurate delimitation of fish stocks, providing missing parameter estimates for complex population dynamics models (e.g., natural mortality), providing useful behavioral data on the vulnerability to fishing (e.g., spawning aggregations, catchability), and serving as a tool to monitor by-catch (release) survival (Figure 3). Fisheries management is usually based on stock units defined as the biomass within a geographic region where the population is self-sustaining (Walters & Martell, 2005). Delineation of population structure (i.e.,

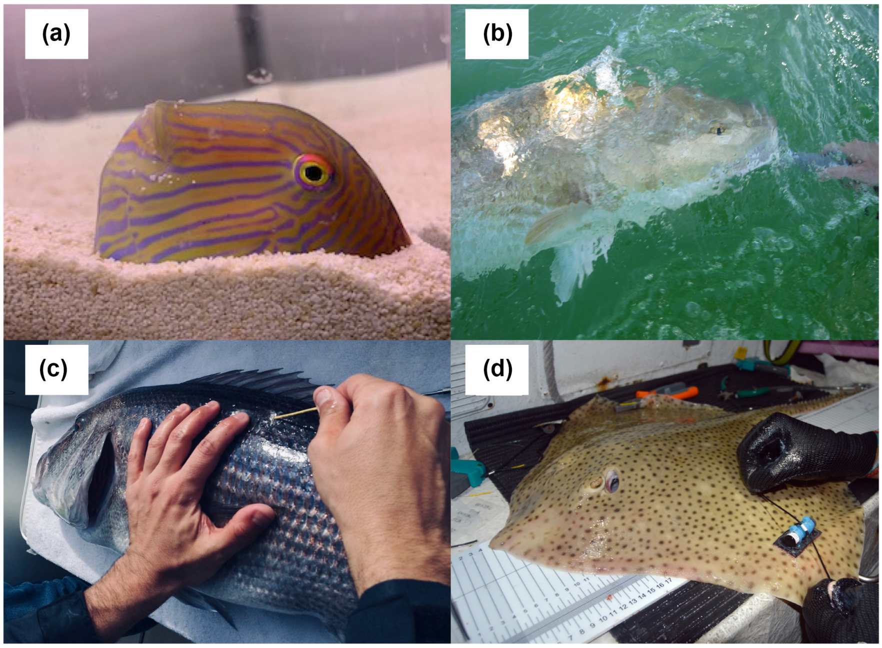

FIGURE 3 Examples of Acoustic animal Tracking (AT) as tool for the sustainable development of the world marine fisheries. (a) The pearly razorfish, *Xyrichtys novacula*: an array of acoustic receivers has revealed that movement variability plays a key role when estimating true abundance from catches (Alós et al., 2019). (b) The red drum, *Sciaenops ocellatus*: AT have been used to estimate its instantaneous monthly and annual fishing mortality, a key parameter for fisheries management, in two coastal Alabama rivers (Nelson & Powers, 2020). (c) The common dentex, *Dentex dentex*: a combination of AT and data-driven modelling approaches provided a tool to identify aggregation areas that make this species highly vulnerable to fishing (Aspillaga et al., 2017). (d) The blonde ray, *Raja brachyura*: a fixed array of acoustic receivers revealed a 100% survival after being caught by a trammel net and discarded by small-scale fishing boats (Alonso-Fernández et al., 2021).

stocks) is thus crucial to successfully manage fisheries. Historically, the spatial distribution of exploited species was described through fishers' and managers' knowledge, fisheries surveys, and a combination of mark–recapture data but had little consideration in classical stock assessments, especially at the individual level. In the last decades, AT has provided new evidences for a much more accurate definition of stock units for exploited animals (Hays et al., 2019; Lédée et al., 2021). For instance, the management boundaries encompassing stocks of the seasonally migrating Greenland halibut *Reinhardtius hippoglossoides* in the Canadian Arctic have been recently redefined according to the results of AT experiments performed in the deep-water polar environment (Hussey et al., 2017).

AT can help attaining sustainable fisheries by providing better estimates of the parameters feeding population dynamic models that serve to estimate biological reference points (e.g., MSY). AT studies are providing better estimates of Spawning Stock Biomass (SSB) by incorporating aspects such as spawning site selection, spawning frequency, and reproductive timing (Lowerre-Barbieri et al., 2017). AT can also directly estimate the different sources of individual mortality (natural and fishing mortality) over the years by directly measuring its variability, which cannot be done otherwise using indirect methods (Block et al., 2019; Friedl et al., 2013). For instance, Heupel and Simpfendorfer (2002) found that estimates of total mortality in juvenile blacktip reef sharks *Carcharhinus limbatus* obtained from acoustic telemetry were considerably higher than those based on a constant lifetime mortality value generated by indirect life-history based methods. Crucially, AT renders population dynamics spatially explicit as it measures different aspects of the spatiotemporal distribution of individuals. Besides the ability to potentially describe fish stocks, AT can be used to estimate other spatiotemporal behaviors like emigration (Scheffel et al., 2020) or spatial vulnerability (Alós et al., 2012). For instance, Hightower et al. (2001) provided the first estimates of emigration (which allowed to estimate natural and fishing mortality) of males and females in a lake population of striped seabass using active AT to relocate tagged fish. Another relevant fisheries parameter that can benefit from AT is the catchability coefficient. Catchability represents the efficiency of harvesting, constituting a key link among fishers and fish stocks (Arreguín-Sánchez, 1996). Alós et al. (2019) used AT and underwater cameras to unveil spatial behavioral types (SBT) that lead to CPUE inevitably declining faster than N (hyperdepletion) compared with a model lacking SBT, demonstrating that catchability coefficients obtained from AT may notably improve stocks assessments by providing a more reliable CPUE-N relationship.

Sustainable exploitation may be affected by selective harvesting and its associated phenotypic change (Jørgensen et al., 2007). There is substantial evidence in the context of commercial fisheries that intensive and size-selective harvesting selects for “fast life-histories” (Heino et al., 2015). Movement and behavioral traits have been recently suggested to be under strong selection in fisheries either due to direct selection acting on such traits or to indirect selection emerging from correlation with life-history (Arlinghaus et al., 2017).

Hence, individual heterogeneity in relation to expressed behavioral traits such as space use, refuge seeking, energy acquisition (e.g., swimming activity), or aggression should play a major role in the catch vulnerability of fish, majorly affecting MSY (Alós et al., 2012). Several authors have demonstrated empirically this hypothesis using AT. For instance, Alós et al. (2016) demonstrated that high exploitation rates favoured individuals with small home ranges and low exploration rates, while Olsen et al. (2012) demonstrated that individuals of Atlantic cod that perform larger diel vertical migrations are more vulnerable to fishing. AT can therefore produce novel insights into the role of behavior on vulnerability and selection of individuals, and contribute to improve population dynamics models by providing better trait-based mortality estimates.

In addition to stock and population dynamics assessment, AT can contribute to improve the management of by-catch, that is, the incidental capture of non-target marine animals within the objectives of the SDG14. Many fish, turtles, sharks, and birds are accidentally captured by commercial fisheries and released every year (Lewison et al., 2004). AT can provide survival estimates of discarded individuals and promote better practices to maximize survival. For example, Alonso-Fernández et al. (2021) used a fixed AT array and recapture data to estimate short and long-term survival of a community of coastal elasmobranchs after being captured by long-lines, obtaining survival rates ranging from 70% to 66% in thornback ray *Raja clavata*, 100% in blonde ray *Raja brachyura* and undulate ray *Raja undulata*, and 100%–92% in dogfish. For undulate ray, the survival rate was reduced to 49% in bottom trawl fisheries using the same assessment methodology (Morfin et al., 2019). AT also demonstrated that tiger sharks *Galeocerdo cuvier* caught alive in long-line gear experience negligible post-release mortality only if adequately handled (Afonso & Hazin, 2014). Furthermore, the increasing participation in recreational catch-and-release angling generates large numbers of voluntary fish releases around the globe (Arlinghaus et al., 2019). The fate of released individuals has received substantial scientific interest and several studies suggest high survival rates (Arlinghaus et al., 2007), and several studies have demonstrated the potential of AT to determine post-release factors to design plans to maximize survival (Donaldson et al., 2008). Ferter et al. (2015) found that Atlantic cod survived a catch and release event and did not show any behavioral changes. In a similar approach combining AT and satellite tracking, Ferter et al. (2017) demonstrated that Atlantic halibut, *Hippoglossus hippoglossus*, is resilient to catch-and-release angling. AT has also been used to assess the post-release mortality due to predation in bonefish *Albula* spp. in both the Seychelles (Moxham et al., 2019) and the Bahamas (Danylchuk et al., 2007), and has demonstrated that that the stress of capture and release did not affect spawning aggregation of common snook, *Centropomus undecimalis* (Lowerre-Barbieri et al., 2003). Curtis et al. (2015) used an array of acoustic receivers to assess the effect of capture depth in the survival of northern red snapper demonstrating a higher survival at cooler temperatures and shallower depths, and similar survival through venting the swim bladder prior to release. Finally, the survival of a range of deep-sea fishes and sharks was assessed using AT in the Azores, also revealing the importance of good handling and release practices (O'Neill et al., 2019). Therefore, AT has contributed to demonstrate that catch-and-release may be an effective management strategy to reduce fishing-induced mortality and hence promote sustainable exploitation in marine fisheries.

6 | SDG14 TARGET 5—DELINEATING MARINE PROTECTED AREAS AND IDENTIFICATION OF ESSENTIAL HABITATS USING ACOUSTIC ANIMAL TRACKING

One of the measures to protect, preserve, and restore marine species and ecosystems that has received more attention and support from the scientific community over the last thirty years is the implementation of MPAs (e.g., Allison et al., 1998; Costanza et al., 1998; Pauly et al., 2002; Roberts et al., 2005). In fact, under the auspices of the United Nations SDG14 the target was to fully protect at least 10% of coastal and marine areas by 2020. Yet, only 7.65% of MPA coverage has been reached so far (UNEP-WCMC and IUCN, 2021). While there is widespread recognition of the potential of MPAs to achieve conservation and fisheries management goals (e.g., Claudet et al., 2008; Goñi et al., 2010) and to buffer the effects of climatic change (Roberts et al., 2017), the proper design and functioning of MPAs is frequently impaired by the many knowledge gaps about key ecological aspects. Despite several studies on best practices for the design and management of MPAs, in most cases their implementation does not take in consideration local empirical data or spatially explicit models (e.g., Botsford et al., 2003; Grafton & Kompas, 2005; Grüss et al., 2011; McCook et al., 2010; Schmiing et al., 2009).

The advances in AT technology allowed the use of acoustic transmitters in increasingly smaller individuals and for longer periods of time, allowing scientists to obtain long term data on the individual movement patterns for many marine species, including the earlier life stages (Shillinger et al., 2012). The information provided by such AT studies has several relevant uses for MPA design and management. Many studies stress the importance of spatial information namely home range areas, site fidelity, and movement patterns for the adequate design and management of MPAs (Abecasis et al., 2014b; Costello et al., 2010; Grüss et al., 2011; Le Quesne & Codling, 2009). By estimating species home range areas AT provides pertinent information regarding the minimum size of MPAs to provide adequate protection (Green et al., 2015), and combining multispecies home range and distribution models aids assessment of multispecific MPA effectiveness (Abecasis et al., 2014b). AT can also provide information on movement barriers, which is an important aspect to consider for MPA networks design since it allows the identification of natural barriers that can therefore be used as MPA boundaries. The identification of a species' preference in habitat use can point to priority habitats for protection, from coastal waters to seamounts (Abecasis et al., 2014a; Afonso et al., 2012;

Lea et al., 2016; McCook et al., 2010). This is particularly important for the conservation of highly mobile species given that the identification of essential fish habitats (e.g., spawning, nursery, feeding) allows the protection of aggregation locations and important areas for species conservation (Abecasis, Afonso, et al., 2013; Abecasis, Bentes, et al., 2013; Afonso et al., 2009; Schofield et al., 2013).

Additionally, AT studies can infer activity patterns (diel, seasonal, yearly) helping to identify migration/aggregation seasons, migration corridors, and connectivity distances of juveniles and adults, which are key aspects toward the correct design of well-connected MPA networks (Martín et al., 2020). Although most aquatic (reef) species have their largest dispersal during the propagule phase, understanding juvenile and adult connectivity is important to fully comprehend spillover effects and thus maximize the benefits of MPA networks. Combining AT with abundance and biomass data (obtained via experimental fishing or underwater visual census) is an efficient tool to monitor the effects and assess the efficiency of MPAs providing relevant information for adaptive management (e.g., Abecasis et al., 2014a, 2014b, 2015; Lea et al., 2016; Villegas-Ríos et al., 2021).

The recent development of spatially explicit management and ecosystem models that incorporate home range areas is also relevant even though their effective application in MPA management is still lacking (Evans et al., 2013). In addition, the use of conservation planning software, such as Marxan and Zonation (Ball et al., 2009; Moilanen & Kujala, 2008), has made the task of designing MPAs more systematic, based on different information layers (geographical, biological, socio-economical), supported by empirical information and therefore more easily accepted by stakeholders. Information on species distribution and home range areas generated by AT can and should be used as data layers within conservation planning software as these provide highly important information, especially regarding key species and habitat protection.

7 | SDG14 TARGET 6—PREVENTING ILLEGAL, UNREPORTED, AND UNREGULATED FISHING USING ACOUSTIC TRACKING

Illegal, unreported, and unregulated (IUU) fishing involves fishing activities that do not respect rules adopted at either national or international level contributing to unsustainable fishing practices (Pitcher et al., 2002; Sumaila et al., 2006). Combating IUU fishing is a top SDG14 priority as a mean toward a rapid and lasting recovery of fisheries (Brashares et al., 2004). In an attempt to fight IUU fishing, large sums of money are invested on the monitoring, control, and surveillance of fisheries without reaching, in most cases, the desired results (Bergh & Davies, 2002). For instance, in West Africa (one of the regions most affected by IUU fishing in the world) only ~0.5% of the economic benefits generated by IUU fishing (estimated at 2.3 billion $ per year) are recovered (Doumbouya et al., 2017). Although satellite-based surveillance provides with a cost-saving alternative to monitoring, control, and surveillance tools (i.e., the Vessel Monitoring Systems and the Automatic Identification System, Bruce et al., 2018; Kroodsma et al., 2018; McCauley et al., 2016; Watson & Haynie, 2016), fishing vessels can switch off or manipulate these systems to hide their identity and location (Kontopoulos et al., 2020; Long et al., 2020).

AT provides a very useful and promising alternative tool to detect and fight IUU fishing through the monitoring of the fate of aquatic (fished) animals. Indeed, a wide array of studies demonstrated how mortality can be detected from acoustic detection patterns of tagged individuals (Heupel & Simpfendorfer, 2002; Hightower et al., 2001; Olsen et al., 2012; Pollock et al., 2004; Topping & Szedlmayer, 2013). Importantly, the added capability of AT to discriminate between fishing *vs.* natural mortality events represents an important step toward detecting IUU fishing events (Pine et al., 2003; Villegas-Ríos et al., 2020). According to Villegas-Ríos et al. (2020), fishing mortality can be inferred from specific detection patterns (red square in Figure 4). As an example, unusual sudden drops in activity amongst the acoustically tagged grey reef shark *Carcharhinus amblyrhynchos* and silvertip sharks *Carcharhinus albimarginatus* that commonly remain within the range of detection arrays for long periods (Barnett et al., 2012; Espinoza et al., 2015) was key to corroborate illegal operations conducted by suspicious vessels around protected coral reefs (Tickler et al., 2019).

To detect IUU activities using AT, the area intended to be protected needs to be monitored via a denser receiver array with overlapping detection ranges, and the target species needs to show high site fidelity or home range within the array (Tickler et al., 2019; Villegas-Ríos et al., 2020). As a complementary tool, an AT monitoring system would also have the potential to detect IUU fishing via the detection of suspicious vessels using autonomous passive noise recorders (Figure 4). Such technologies, including the hydrophone Buoy (Stolkin et al., 2006) or the simplest and low-cost Portable Noise Recorder System (Salloum et al., 2018), are able to detect, track, and classify vessels based on their noise signature (Fillinger et al., 2011; Simard et al., 2016; Pollara et al., 2017; yellow square in Figure 4). Such harmonic footprint is modulated by mechanical characteristics of the vessels (e.g., engine size, propellers cavitation; Kudryavtsev et al., 2003; Pollara et al., 2017), and as a result, a noise-based classification of vessels can be conducted (Santos-Domínguez et al., 2016). Moreover, the passive nature of AT and autonomous noise recorders provide a low-cost monitoring strategy not only economically but also logistically, since these systems can cover the surveillance of several kilometres (detection distance could reach ~24 km in the open sea, Salloum et al., 2018). AT schemes are also effective in a way that do not require the buy-in and action of multiple stakeholders, could transmit the information in real-time, and are particularly effective in situations where silent, undetectable monitoring of IUU activity is required. It is thus reasonable to extend the application of this passive acoustic modality to the detection of vessels involved in IUU activities in combination with active AT of marine biodiversity (Salloum et al., 2018 and Figure 4).

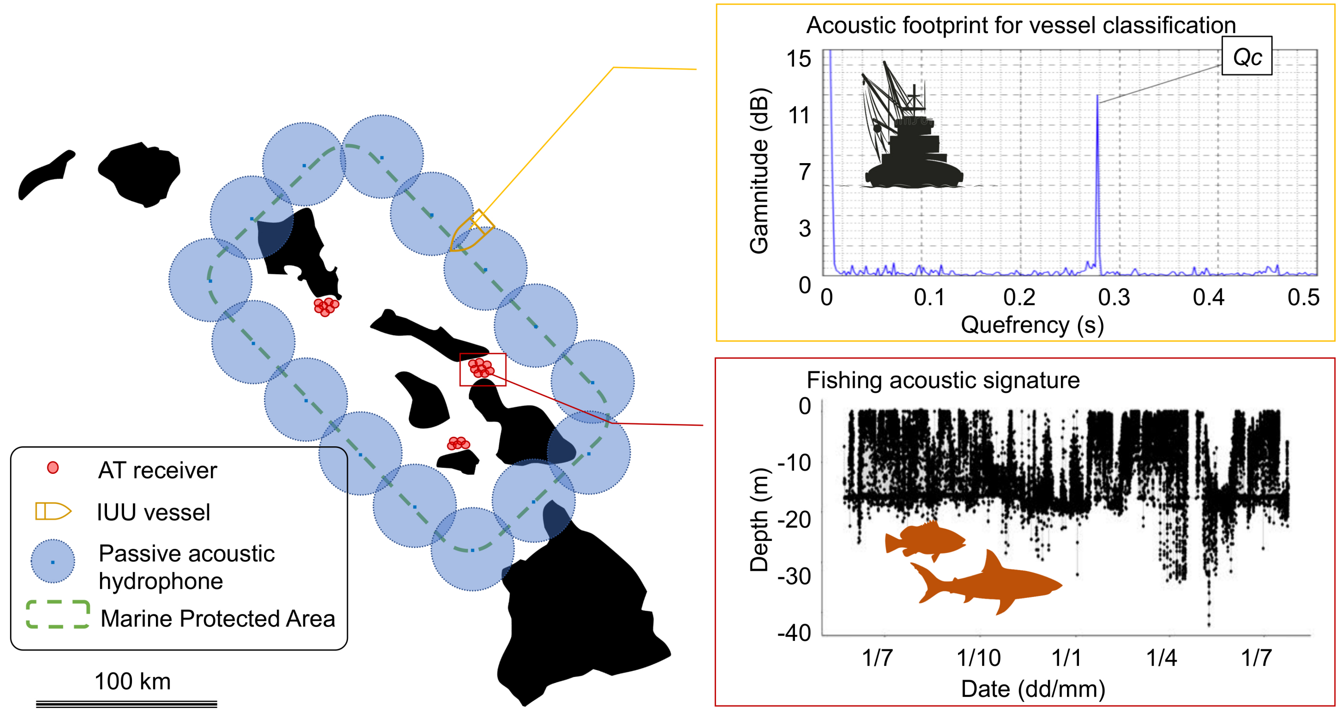

FIGURE 4 Schematic of a potential Integral Acoustic Surveillance System combining both monitoring of species and vessels at a prototypical tropical archipelago, where a marine protected area has been recently declared. Illegal, unreported, and unregulated vessels' intrusions would be detected by a passive acoustic hydrophones array (blue points, the blue shadow denotes a conservative detection range of 12 km; Salloum et al., 2018) deployed along MPA boundaries at the sea bottom with a surface antenna/satellite communication buoy to transmit illegal activity in nearly real-time. Top yellow square details the potential acoustic footprint which would be detected and classified as a big vessel (graph extracted from Pollara et al., 2017). The peak related to engine cylinder rates are labelled with *Qc*. Several coral reefs are monitored by a dense receiver array with overlapping detection ranges (small red points with a ~1 km detection range highlighted by the red shadow). One of these dense arrays would detect the illegal harvest of target species (e.g., groupers or sharks). Red square shows a fishing acoustic signature (the first fate above-described) detected by receivers (figure modified from Villegas-Ríos et al., 2020).

8 | SDG14 TARGET 7—DEVELOPMENT OF SMALL ISLAND NATIONS AND DEVELOPING COUNTRIES

Small Island Nations have strong ties to the ocean and are key stakeholders in blue growth agendas. SDG14 Target 7 focuses on increasing the economic benefits of Small Island Developing States (SIDS) and least developed countries by the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture, and tourism by 2030. The anthropological history of these regions is rich in Indigenous settlements, culture, and socio-political systems for autonomous governance that have largely been eroded by European settlement (Filous, Lennox, et al., 2020). According to the UN, the Pacific SIDS' economic zones (EEZs) cover 40 million km^2 of the ocean and are rich in aquatic resources, including a large share of the global tuna stocks.

EEZs around small islands provide potential for both sustainable local food and economic export to international markets. Fisheries resources in these areas include coastal and reef fishes such as parrotfishes, trevallies, snappers, groupers, and triggerfishes among others (Filous et al., 2019), as well as large pelagic migrants, especially tunas and billfishes (Christ et al., 2020). Overfishing of local species is of serious concern and several important species are considered to be at risk (Cinner & McClanahan, 2006; Sumaila et al., 2013). For pelagic species that wander entire ocean basins, fisheries are confronted by jurisdictional challenges as fish pass through EEZs ephemerally before transiting into international waters where they are vulnerable to high seas fisheries.

Monitoring and managing the resources in these coastal waters is key to inform the creation of spatial protection measures in small islands and remote areas (Chateau & Wantiez, 2007; Daly et al., 2020). Coastal arrays of AT receivers along sand flats, seagrass meadows, coral reefs, tidal creeks, and island slopes including nearby seamount summits can facilitate long-term population monitoring to identify habitat selection, migratory corridors, spawning sites, and drivers of movement on key reef species, including the deeper demersal fishes and sharks (Afonso et al., 2012; Danylchuk et al., 2011; Filous, Lennox, et al., 2020; Figure 5). Pelagic, highly migratory species are more challenging to track, but marine buoys including platforms of opportunity such as aquatic floating drones, gliders equipped with acoustic receivers (Haulsee et al., 2015) or fish aggregating devices can be instrumental to investigate how species such as tuna associate with these devices and determine their use and vulnerability at being captured, among others research questions (Filous, Friedlander, et al., 2020). AT in pelagic zones and key aggregating sites (e.g., seamount summits) can be paired with other

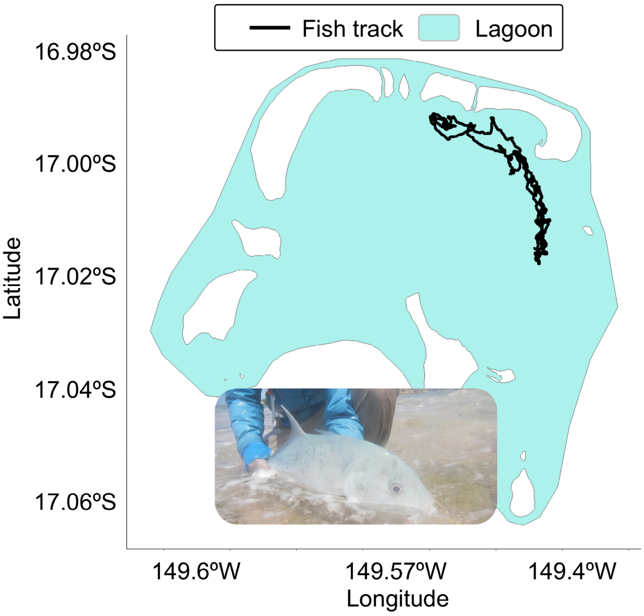

FIGURE 5 Acoustic animal Tracking (AT) can contribute, at a reasonable price, with cutting-edge, autonomous, and easy to deploy technology that can generate scientific data to promote the economic benefits by the sustainable use of marine resources in Small Island Developing States and least developed countries. The Figure shows a track generated by an AT experiment and a picture of a giant trevally *Caranx ignobilis*, an important predator of the tropical Indo-Pacific reefs, at Tetiaroa lagoon, French Polynesia. The results of this study provided the first detailed data on habitat use in this species and suggested MPAs as an effective tool for its conservation (Filous et al., 2019).

tracking tools (e.g., FastLoc GPS, SPOT, and PSAT tags) to generate multiscale information on animals that spend little time around the receivers.

In the context of SDG14, AT has a vast potential for action and evidence-based management. There are a myriad of examples of AT guiding design and implementation of protected areas, which meaningfully contributes to protection and enhancement of local biodiversity. Tagging and tracking species provides residency indexes within and beyond protected areas to determine which species are protected and for how long (Daly et al., 2020; Marshell et al., 2011; Meyer et al., 2007). Sustainable use is also advanced via local and traditional fisheries management or regulatory governance. Filous, Lennox, et al. (2020) studied short jaw bonefish *Albula glossodonta* in Anaa, French Polynesia and found seasonal trends in migration of females that informed local adoption of fishing closures, which have been promising for stock rebuilding in the first few years (Filous et al., 2019; Filous, Lennox, et al., 2020). The use of AT will continue to focus on coastal species but emergence of TN and the use of platforms of opportunity may allow larger pelagic animals to increasingly be detected to inform local small-scale fishing operations targeting these species.

Small Island Nations are disproportionately threatened by human activities resulting in sea level rise, coral reef bleaching, and fisheries overexploitation, imperilling their livelihoods and food security. There is abundant Indigenous knowledge on fish and fisheries management, and researchers should conduct their studies respectfully and with a spirit of inclusivity from study design to implementation (Reid et al., 2021). Proper permissions should be sought, and researchers should work closely with stakeholders, particularly local fishers, before, after, and during AT studies. Most researchers will be foreigners in Small Island Nations and should be cognizant of historical colonial contexts to avoid past failures (Chin et al., 2019). Indigenous knowledge systems are often complementary with western science when fish capture, acoustic receiver deployments and maintenance, and data mining are conducted cooperatively with locals (Filous, Friedlander, et al., 2020). Research on local culturally and economically important resources will usually cause local conflicts because not everyone in a community will agree on the benefits and risks, and the findings may or may not ultimately contribute to changes in management modes. Nevertheless, being inclusive, communicative, and open about AT research will usually maximize its impact.

9 | THE NEED FOR LARGE-SCALE, COLLABORATIVE TRACKING NETWORKS ACHIEVING SDG14 TARGETS

The examples provided in previous sections have shown that AT is commonly applied to investigate the spatial ecology and behavior of aquatic species in relation to their environment. However, the SDG14 aims for sustainable development at a global level. Thus, although regional and local initiatives might play an important role to achieve the seven major Targets of SDG14 much emphasis is needed at a broader, international scale in the form of collaborative TNs. Aquatic animals do not restrict their movements to administrative borders and can migrate over extensive distances between feeding, breeding, and nursing habitats (Fujioka et al., 2018). We highlight two examples of relevant scientific outcomes that are based on TNs achieving SDG14 targets. First, Block et al. (2019) provided the first rate of instantaneous annual natural mortality, a key parameter for sustainable fisheries and MSY, for the Atlantic bluefin tuna *Thunnus thynnus* using acoustic tags and deploying acoustic receiver lines across the entrances of the Gulf of St. Lawrence in Canada. Second, to understand the implications of fish stocks being distributed across several EEZs as well as international waters, Lédée et al. (2021) used continental-scale AT and network analysis techniques to provide novel insight on the movement of seven teleost and seven shark species. Their findings allowed to compare their results with genetic and conventional tagging studies. These two examples show how TNs provide a scientific basis for management and conservation, and can significantly improve our understanding of ecosystem functioning and dynamics (Abecasis et al., 2018; Lowerre-Barbieri et al., 2021). This, in combination with the inherent nature of many aquatic animals to move over large distances, explains the recent need to move toward implementing large-scale, cross-boundary networks (Ellis et al., 2019), being the European Tracking Network (ETN, Abecasis

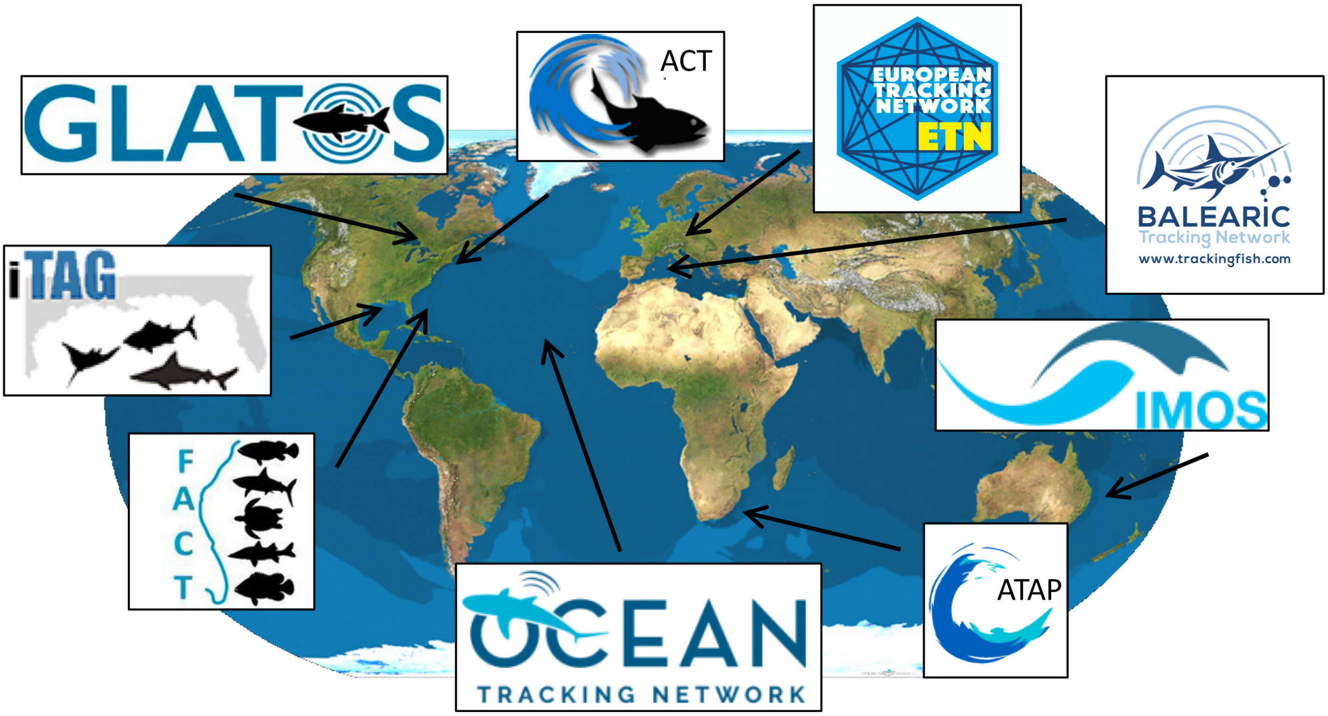

FIGURE 6 Cooperation through Tracking Networks is fundamental for a Decade of Ocean Science for Sustainable Development of Marine Biodiversity through Acoustic animal Tracking (AT). Integrated and coordinated networking of AT provides now the opportunity of tracking marine animals all around the globe in the long term (>10 years). The Figure show a selection of existing Networks: iTag—Integrated Tracking of Aquatic Animals in the Gulf of Mexico (https://itagscience.com/), IMOS—Integrated Marine Observing System (https://imos.org.au/), ACT—The Atlantic Cooperative Telemetry Network (https://www.theactnetwork.com/), FACT—Florida Atlantic Coast Telemetry Network (https://secoora.org/fact/), OTN—Ocean Tracking Network (http://www.oceantrackingnetwork.org/), GLATOS—The Great Lakes Acoustic Telemetry Observation System (https://glatos.glos.us/), ATAP—South Africa's Acoustic Tracking Array Platform (ATAP) (https://saveourseas.com/project/the-acoustic-tracking-array-platform-atap/), ETN—European Tracking Network (http://www.europeantrackingnetwork.org/), BTN—Balearic Tarcking Network (https://trackingfish.com/).

et al., 2018), Ocean Tracking Network (OTN, Iverson et al., 2019), or Florida Atlantic Coast Telemetry working group (FACT, Young et al., 2020) some examples (Figure 6).

The leap from local studies on single species and habitats, toward international and global networks facilitating multispecies monitoring over multiple habitats and pressures creates many advantages at several levels. First, the presence of telemetry infrastructure over large geographical and temporal scales greatly enhances the potential and value of the projects and the data generated to identify key factors determining populations' health. The initially planned monitored areas and fish detections increase and research collaborations are facilitated (Ellis et al., 2019). Second, most TNs provide data management services, which improve efficiency, encourage data sharing, and facilitate the access to automated data management (Young et al., 2020). Leading to collaborations and stakeholder engagement at a broader scale, over different species and habitats (Abecasis et al., 2018; Reubens et al., 2019), resulting in an increased funding success for TNs. Third, these global networks allow for the multi-decadal detection of unexpected and unknown movements, as well as shedding light on the somewhat restricted acoustic monitoring on long-distance migrants.

10 | DISCUSSION AND CONCLUSIONS

We have reviewed how AT can actively contribute to achieve most of the SDG14 Targets. Overall, the applications of AT in the study of the effects of pollution on species survival, distribution, and movement is of most importance for the preservation of aquatic fauna and ensure safe marine-derived products for human consumption. The effects of anthropogenic sound pollution (an emergent pollutant) in marine organisms have not yet been extensively studied (Duarte et al., 2021). It is known that certain marine species are attracted or repulsed by artificial light sources constituting a type of pollution (Marangoni et al., in press). More research is needed to understand the ecological implications of such behavioral changes (Nightingale et al., 2006). AT is a promising monitoring tool that can help the development of informed managerial decisions by directly measuring the behavioral effects related to the long-term exposure to pollutants.

AT makes possible to establish a baseline behavioral data that should be gathered prior to the deployment of large human-infrastructures (e.g., current plan for deploying large-scale marine wind farms across Europe). AT has been successfully used to monitor the response of marine fish to restoration-monitoring programs, or to evaluate the effectiveness of artificial reefs (Abecasis, Afonso, et al., 2013; Abecasis, Bentes, et al., 2013; Espinoza et al., 2011). Stock enhancement and repopulation of marine biodiversity is also an important management and restoration measure in response to poor fishery performance or to compensate for stock depletion (Taylor et al., 2017). AT serves as a tool, not only to measure the survival of stocked animals, their movement, and habitat selection to identify the importance of release location but also to measure the impacts on native biodiversity (Pursche et al., 2014; Taylor et al., 2013).

The stratification of the water column has become stronger and extreme events, such as heatwaves, are now more recurrent than before (IPCC, 2019). AT has a great potential to improve our understanding on the long-term effects of climate change on aquatic organisms by studying the effect of environmental variables on free-ranging organisms. AT infrastructures encompassing a wider range of climatic conditions, local stressors, and flagship sentinel species, will be key to extending the behavioral and physiological studies to the scale required by the social and conservation challenges, and to achieve sustainable management international commitments (Abecasis et al., 2018).

Sustainable fisheries rely on effective, evidence-based fisheries management actions. AT is currently an underused resource within formal fisheries management (Matley et al., 2022), where its potential to directly delineate stocks or estimate demographic parameters has yet to be fully developed (Crossin et al., 2017). AT can provide estimates of post-release mortality allowing for the identification of ways to reduce it (e.g., through gear modifications, Bettinger et al., 2005). A central feature of the agenda and a goal of the oceans SDG14 is the protection of at least 10% of coastal and marine areas. In fact, target 5, related to MPA will dominate the SDG14 measures since protected areas are a ‘privileged’ solution in conservation, specifically in marine conservation. Targets of becoming MPAs are (relatively) SMART (Specific, Measurable, Achievable, Realistic, and Time-bound); and the opportunity for MPA expansion is vast. As advocacy for MPAs grows around the world, it is essential that MPA scientists directly tackle the challenges of evaluating the performance of MPAs using the best available scientifically based data, and AT can demonstrate the potential both before (baseline), during, and after the protection (Dwyer et al., 2019; Martín et al., 2020).

SDG14 aims to effectively regulate harvesting and end IUU fishing and destructive fishing practices. We have shown how combining both acoustic strategies (acoustic monitoring of species and vessels) with an Integral Acoustic Surveillance strategy (Figure 4) would contribute to the task of fighting IUU fishing as a hidden and cost-effective surveillance tool, as well as providing with a complementary technique to the monitoring, control, and surveillance strategies (Salloum et al., 2018). The use of AT will continue to focus on coastal species but emergence of TNs and the use of platforms of opportunity may allow larger pelagic animals to increasingly be detected and thus inform local small-scale fishing operations targeting these species and specially focusing on the economic benefits to Small Island Developing States and least developed countries.

The open ocean and the deep-sea make up for the vast majority of our oceans' surface and volume, yet we are still lagging well behind in understanding the functioning and interactions of these ecosystems. We are only now perceiving that oceanic organisms, including large vertebrates, appear to use these ecosystems tridimensionally in ways that challenge the classical scientific views (Braun et al., 2022). Understanding how these higher trophic levels depend on the massive yet threatened mesopelagic biodiversity and biomass (Martin et al., 2020), orders of magnitude higher than in coastal areas, will be key to understand how and if humanity can sustainably exploit this resource or else embark in a Pandora's box (St John et al., 2016). AT clearly has a large potential to expand its currently scarce use in deep-sea habitats such as slopes and seamounts (e.g., Afonso et al., 2012; Hussey et al., 2017; Masmitja et al., 2020), including the least known habitats (hydrothermal vents, abyssal plains), albeit this would require a functional response from manufacturers to offer equipment that can go substantially deeper than current depth ratings (500 m).

Finally, to fully exploit AT and achieve the Targets of the SDG14, it requires a trans-boundary collaborative effort in the form of global networks. TNs that can cover substantial volumes of the open ocean are a challenging endeavour, given the current limitations in range that AT offers. However, it remains as a promising tool especially if designed to be placed at ecological ‘hotspots’, that is, protected areas on the high seas (Maxwell et al., 2020). The ultimate goal of TNs is to leverage research that is capable of addressing social challenges, defined under the SDG, and to achieve Good Environmental Status of our oceans and seas. Decision-making and management practices and policies should be based on sound and excellent science, which is enabled by the TNs and will directly benefit the long-term economy and environmental status of the oceans. Achieving the trade related targets of SDG14 requires the catalysis of policies, investment, and innovations to restore the productive capacity of the oceans and increase economic benefits to developing countries, in particular Small Islands Developing States and least developed countries. Innovative AT-based solutions that integrate best practices for harvesting, value addition in processing, and distribution can benefit greatly from opportunities offered around the concepts of ocean economy/blue economy and eco-labelling.

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CONFLICT OF INTEREST

All authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The manuscript does not contain data as it is a Review of cases.

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REFERENCES

Aarestrup, K., Baktoft, H., Koed, A., del Villar-Guerra, D., & Thorstad, E. B. (2014). Comparison of the riverine and early marine migration behaviour and survival of wild and hatchery-reared sea trout *Salmo trutta* smolts. *Marine Ecology Progress Series*, *496*, 197–206. https://doi.org/10.3354/meps10614

Abecasis, D., Bentes, L., Lino, P. G., Santos, M. N., & Erzini, K. (2013). Residency, movements and habitat use of adult white seabream (*Diplodus sargus*) between natural and artificial reefs. *Estuarine, Coastal and Shelf Science*, *118*, 80–85. https://doi.org/10.1016/j.ecss.2012.12.014

Abecasis, D., Horta e Costa, B., Afonso, P., Gonçalves, E. J., & Erzini, K. (2015). Early reserve effects linked to small home ranges of a commercial fish, *Diplodus sargus*, Sparidae. *Marine Ecology Progress Series*, *518*, 255–266. https://doi.org/10.3354/meps11054

Abecasis, D., Afonso, P., & Erzini, K. (2014a). Can small MPAs protect local populations of a coastal flatfish, *Solea senegalensis*? *Fisheries Management and Ecology*, *21*(3), 175–185. https://doi.org/10.1111/fme.12061

Abecasis, D., Afonso, P., & Erzini, K. (2014b). Combining multispecies home range and distribution models aids assessment of MPA effectiveness. *Marine Ecology Progress Series*, *513*, 155–169. https://doi.org/10.3354/meps10987

Abecasis, D., Afonso, P., O'Dor, R. K., & Erzini, K. (2013). Small MPAs do not protect cuttlefish (*Sepia officinalis*). *Fisheries Research*, *147*, 196–201. https://doi.org/10.1016/j.fishres.2013.05.004

Abecasis, D., Steckenreuter, A., Reubens, J., Aarestrup, K., Alós, J., Badalamenti, F., Bajona, L., Boylan, P., Deneudt, K., Greenberg, L., Brevé, N., Hernández, F., Humphries, N., Meyer, C., Sims, D., Thorstad, E. B., Walker, A. M., Whoriskey, F., & Afonso, P. (2018). A review of acoustic telemetry in Europe and the need for a regional aquatic telemetry network. *Animal Biotelemetry*, *6*(1), 12. https://doi.org/10.1186/s40317-018-0156-0

Addis, D. T., Patterson, W. F., Dance, M. A., & Ingram, G. W. (2013). Implications of reef fish movement from unreported artificial reef sites in the northern Gulf of Mexico. *Fisheries Research*, *147*, 349–358. https://doi.org/10.1016/j.fishres.2013.07.011

Afonso, A. S., & Hazin, F. H. V. (2014). Post-release survival and behavior and exposure to fisheries in juvenile tiger sharks, *Galeocerdo cuvier*, from the South Atlantic. *Journal of Experimental Marine Biology and Ecology*, *454*, 55–62. https://doi.org/10.1016/j.jembe.2014.02.008

Afonso, P., Fontes, J., Holland, K. N., & Santos, R. S. (2009). Multi-scale patterns of habitat use in the white trevally, *Pseudocaranx dentex*, a highly mobile reef fish: Implications for marine reserve design. *Marine Ecology Progress Series*, *381*, 273–286.

Afonso, P., Graça, G., Berke, G., & Fontes, J. (2012). First observations on seamount habitat use of blackspot seabream (*Pagellus bogaraveo*) using acoustic telemetry. *Ecology*, *436-437*, 1–10. https://doi.org/10.1016/j.jembe.2012.08.003

Allison, G. W., Lubchenco, J., & Carr, M. H. (1998). Marine reserves are necessary but not sufficient for marine conservation. *Ecological Applications*, *8*(1), 79–92. https://doi.org/10.1890/1051-0761(1998)8

Alonso-Fernández, A., Mucientes, G., & Villegas-Ríos, D. (2021). *Discard survival of coastal elasmobranchs in a small-scale fishery using acoustic telemetry*. Iberian Symposium on Modeling and Assessment of Fishery Resource.

Alós, J., Campos-Candela, A., & Arlinghaus, R. (2019). A modelling approach to evaluate the impact of fish spatial behavioural types on fisheries stock assessment. *ICES Journal of Marine Science*, *76*(2), 489–500. https://doi.org/10.1093/icesjms/fsy172

Alós, J., Palmer, M., & Arlinghaus, R. (2012). Consistent selection towards low activity phenotypes when catchability depends on encounters among human predators and fish. *PLoS ONE*, *7*(10), e48030. https://doi.org/10.1371/journal.pone.0048030

Alós, J., Palmer, M., Rosselló, R., & Arlinghaus, R. (2016). Fast and behavior-selective exploitation of a marine fish targeted by anglers. *Scientific Reports*, *6*(April), 1–13. https://doi.org/10.1038/srep38093

Andrews, O. D., Bindoff, N. L., Halloran, P. R., Ilyina, T., & Le Quéré, C. (2013). Detecting an external influence on recent changes in oceanic oxygen using an optimal fingerprinting method. *Biogeosciences*, *10*(3), 1799–1813. https://doi.org/10.5194/bg-10-1799-2013

Arendt, M., Lucy, J., & Munroe, T. (2001). Seasonal occurrence and site-utilization patterns of adult tautog, *Tautoga onitis* (Labridae), at manmade and natural structures in Lower Chesapeake Bay. *Fishery Bulletin*, *99*(4), 519–527.

Arlinghaus, R., Abbott, J. K., Fenichel, E. P., Carpenter, S. R., Hunt, L. M., Alós, J., Klefoth, T., Cooke, S. J., Hilborn, R., Jensen, O. P., Wilberg, M. J., Post, J. R., & Manfredo, M. J. (2019). Opinion: Governing the recreational dimension of global fisheries. *Proceedings of the National Academy of Sciences of the United States of America*, *116*(12), 5209–5213. https://doi.org/10.1073/pnas.1902796116

Arlinghaus, R., Cooke, S. J., Lyman, J., Policansky, D., Schwab, A., Suski, C., Sutton, S. G., & Thorstad, E. B. (2007). Understanding the complexity of catch-and-release in recreational fishing: An integrative synthesis of global knowledge from historical, ethical, social, and biological perspectives. *Reviews in Fisheries Science*, *15*(1–2), 75–167. https://doi.org/10.1080/10641260601149432

Arlinghaus, R., Laskowski, K. L., Alós, J., Klefoth, T., Monk, C. T., Nakayama, S., & Schröder, A. (2017). Passive gear-induced timidity syndrome in wild fish populations and its potential ecological and managerial implications. *Fish and Fisheries*, *18*(2), 360–373. https://doi.org/10.1111/faf.12176

Arreguín-Sánchez, F. (1996). Catchability: A key parameter for fish stock assessment. *Reviews in Fish Biology and Fisheries*, *6*, 221–242. https://doi.org/10.1007/BF00182344

Aspillaga, E., Arlinghaus, R., Martorell-Barceló, M., Follana-Berná, G., Lana, A., Campos-Candela, A., & Alós, J. (2021). Performance of a novel system for high-resolution tracking of marine fish societies. *Animal Biotelemetry*, *9*, 1–14.

Aspillaga, E., Bartumeus, F., Starr, R. M., López-Sanz, À., Linares, C., Díaz, D., Garrabou, J., Zabala, M., & Hereu, B. (2017). Thermal stratification drives movement of a coastal apex predator. *Scientific Reports*, *7*(1), 526. https://doi.org/10.1038/s41598-017-00576-z

Ball, I. R., Possingham, H. P., & Watts, M. (2009). Marxan and relatives: Software for spatial conservation prioritisation. In M. Atte, K. A. Wilson, & H. P. Possingham (Eds.), *Spatial conservation prioritisation: Quantitative methods and computational tools* (pp. 185–195). Oxford University Press.

Barbier, E. B. (2017). Marine ecosystem services. *Current Biology*, *27*(11), R507–R510. https://doi.org/10.1016/j.cub.2017.03.020

Barcelo-Serra, M., Cabanellas, S., Palmer, M., Bolgan, M., & Alós, J. (2021). A state-space model to derive motorboat noise effects on fish movement from acoustic tracking data. *Scientific Reports*, *11*(1), 4765. https://doi.org/10.1038/s41598-021-84261-2

Barnes, D. K. A., Galgani, F., Thompson, R. C., & Barlaz, M. (2009). Accumulation and fragmentation of plastic debris in global environments. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *364*(1526), 1985–1998. https://doi.org/10.1098/rstb.2008.0205

Barnett, A., Abrantes, K. G., Seymour, J., & Fitzpatrick, R. (2012). Residency and spatial use by reef sharks of an isolated seamount and its implications for conservation. *PLoS ONE*, *7*(5), e36574. https://doi.org/10.1371/journal.pone.0036574

Bergh, P. E., & Davies, S. (2002). Fishery monitoring, control and surveillance. In K. L. Cochrane (Ed.), *A fishery manager's guidebook: Management measures and their application* (p. 231). Food and Agriculture Organization of the United Nations (FAO).

Bert, T., Maris, T., Van Damme, S., Blust, R., & Meire, P. (2021). Tracking marked plastic items on their journey through the Scheldt estuary, using the Permanent Belgian Acoustic Receiver Network (PBARN). In J. Mees & J. Seys (Eds.), *Book of abstracts—VLIZ Marine Science Day 2021*. Vlaams Instituut voor de Zee—Flanders Marine Institute (VLIZ).

Bertram, M. G., Martin, J. M., McCallum, E. S., Alton, L. A., Brand, J. A., Brooks, B. W., Cerveny, D., Fick, J., Ford, A. T., Hellström, G., Michelangeli, M., Nakagawa, S., Polverino, G., Saaristo, M., Sih, A., Tan, H., Tyler, C. R., Wong, B. B. M., & Brodin, T. (2022). Frontiers in quantifying wildlife behavioural responses to chemical pollution. *Biological Reviews*, *97*(3), 1346–1364. https://doi.org/10.1111/brv.12844

Bettinger, J. M., Tomasso, J. R., & Isely, J. J. (2005). Hooking mortality and physiological responses of striped bass angled in freshwater and held in live-release tubes. *North American Journal of Fisheries Management*, *25*(4), 1273–1280. https://doi.org/10.1577/M04-156.1

Bjorndal, K. A., Bowen, B. W., Chaloupka, M., Crowder, L. B., Heppell, S. S., Jones, C. M., Lutcavage, M. E., Policansky, D., Solow, A. R., & Witherington, B. E. (2011). Better science needed for restoration in the Gulf of Mexico. *Science*, *331*(6017), 537–538. https://doi.org/10.1126/science.1199935

Block, B. A., Keen, J. E., Castillo, B., Dewar, H., Freund, E. V., Marcinek, D. J., Brill, R. W., & Farwell, C. (1997). Environmental preferences of yellowfin tuna (*Thunnus albacares*) at the northern extent of its range. *Marine Biology*, *130*, 119–132.

Block, B. A., Whitlock, R., Schallert, R. J., Wilson, S., Stokesbury, M. J. W., Castleton, M., & Boustany, A. (2019). Estimating natural mortality of Atlantic bluefin tuna using acoustic telemetry. *Scientific Reports*, *9*(1), 4918. https://doi.org/10.1038/s41598-019-40065-z

Boehlert, G., & Gill, A. B. (2010). Environmental and ecological effects of ocean renewable energy development—A current synthesis. *Oceanography*, *23*(2), 68–81. https://doi.org/10.5670/oceanog.2010.46

Bombace, G. (1989). Artificial reefs in the mediterranean sea. *Bulletin of Marine Science*, *44*(2), 1023–1032.

Botsford, L. W., Micheli, F., & Hastings, A. (2003). Principles for the design of marine reserves. *Ecological Applications*, *13*(1), 25–31. https://doi.org/10.1890/1051-0761(2003)013

Brashares, J. S., Arcese, P., Sam, M. K., Coppolillo, P. B., Sinclair, A. R. E., & Balmford, A. (2004). Bushmeat hunting, wildlife declines, and fish supply in West Africa. *Science*, *306*(5699), 1180–1183. https://doi.org/10.1126/science.1102425

Braun, C. D., Arostegui, M. C., Thorrold, S. R., Papastamatiou, Y. P., Gaube, P., Fontes, J., & Afonso, P. (2022). The functional and ecological significance of deep diving by large marine predators. *Annual Review of Marine Science*, *14*, 129–159.

Breitburg, D., Levin, L. A., Oschlies, A., Grégoire, M., Chavez, F. P., Conley, D. J., Garçon, V., Gilbert, D., Gutiérrez, D., Isensee, K., Jacinto, G. S., Limburg, K. E., Montes, I., Naqvi, S. W. A., Pitcher, G. C., Rabalais, N. N., Roman, M. R., Rose, K. A., Seibel, B. A., … Zhang, J. (2018). Declining oxygen in the global ocean and coastal waters. *Science*, *359*, 6371. https://doi.org/10.1126/science.aam7240

Bruce, B., Bradford, R., Foster, S., Lee, K., Lansdell, M., Cooper, S., & Przeslawski, R. (2018). Quantifying fish behaviour and commercial catch rates in relation to a marine seismic survey. *Marine Environmental Research*, *140*, 18–30. https://doi.org/10.1016/j.marenvres.2018.05.005

Burns, E. S., Wolfe, B. W., Armstrong, J., Tang, D., Sakamoto, K., & Lowe, C. G. (2021). Using acoustic telemetry to quantify potential contaminant exposure of Vermilion Rockfish (*Sebastes miniatus*), Hornyhead Turbot (*Pleuronichthys verticalis*), and White Croaker (*Genyonemus lineatus*) at wastewater outfalls in southern California. *Marine Environmental Research*, *170*, 105452. https://doi.org/10.1016/j.marenvres.2021.105452

Calisi, R. M., & Bentley, G. E. (2009). Lab and field experiments: Are they the same animal? *Hormones and Behavior*, *56*(1), 1–10. https://doi.org/10.1016/j.yhbeh.2009.02.010

Carlsson, G., Örn, S., & Larsson, D. G. J. (2009). Effluent from bulk drug production is toxic to aquatic vertebrates. *Environmental Toxicology and Chemistry*, *28*(12), 2656. https://doi.org/10.1897/08-524.1

Carpenter, S. R., Caraco, N. F., Correll, D. L., Howarth, R. W., Sharpley, A. N., & Smith, V. H. (1998). Nonpoint pollution of surface waters with phophorous and nitrogen. *Ecological Applications*, *8*(3), 559–568. https://doi.org/10.1890/1051-0761(1998)008[0559:NPOSWW]2.0.CO;2

Castro-Santos, T., Bolus, M., & Danylchuk, A. J. (2019). Assessing risks from harbor dredging to the northernmost population of diamondback terrapins using acoustic telemetry. *Estuaries and Coasts*, *42*(2), 378–389. https://doi.org/10.1007/s12237-018-0481-9

Chateau, O., & Wantiez, L. (2007). Site fidelity and activity patterns of a humphead wrasse, *Cheilinus undulatus* (Labridae), as determined by acoustic telemetry. *Environmental Biology of Fishes*, *80*(4), 503–508. https://doi.org/10.1007/s10641-006-9149-6

Chiba, S., Saito, H., Fletcher, R., Yogi, T., Kayo, M., Miyagi, S., Ogido, M., & Fujikura, K. (2018). Human footprint in the abyss: 30 year records of deep-sea plastic debris. *Marine Policy*, *96*, 204–212.

Chin, A., Baje, L., Donaldson, T., Gerhardt, K., Jabado, R. W., Kyne, P. M., Mana, R., Mescam, G., Mourier, J., Planes, S., & Wen, C. (2019). The scientist abroad: Maximising research impact and effectiveness when working as a visiting scientist. *Biological Conservation*, *238*, 108231. https://doi.org/10.1016/j.biocon.2019.108231

Chittenden, C. M., Sura, S., Butterworth, K. G., Cubitt, K. F., Plantalech Manel-La, N., Balfry, S., Økland, F., & McKinley, R. S. (2008). Riverine, estuarine and marine migratory behaviour and physiology of wild and hatchery-reared coho salmon *Oncorhynchus kisutch* (Walbaum) smolts descending the Campbell River, BC, Canada. *Journal of Fish Biology*, *72*(3), 614–628. https://doi.org/10.1111/j.1095-8649.2007.01729.x

Christ, H. J., White, R., Hood, L., Vianna, G. M. S., & Zeller, D. (2020). A baseline for the Blue Economy: Catch and effort history in the Republic of Seychelles' domestic fisheries. *Frontiers in Marine Science*, *7*, 269. https://doi.org/10.3389/fmars.2020.00269

Cinner, J. E., & McClanahan, T. R. (2006). Socioeconomic factors that lead to overfishing in small-scale coral reef fisheries of Papua New Guinea. *Environmental Conservation*, *33*(1), 73–80. https://doi.org/10.1017/S0376892906002748

Clark, T. D., Raby, G. D., Roche, D. G., Binning, S. A., Speers-Roesch, B., Jutfelt, F., & Sundin, J. (2020). Ocean acidification does not impair the behaviour of coral reef fishes. *Nature*, *577*(7790), 370–375. https://doi.org/10.1038/s41586-019-1903-y

Clark, W., Mosely, J., & Stone, R. (1974). Foreword [sic]. In L. Colunga & R. Stone (Eds.), *Proceedings of an International Conference on Artificial Reef* (p. 3).

Claudet, J., Bopp, L., Cheung, W. W. L., Devillers, R., Escobar-Briones, E., Haugan, P., Heymans, J. J., Masson-Delmotte, V., Matz-Lück, N., Miloslavich, P., Mullineaux, L., Visbeck, M., Watson, R., Zivian, A. M., Ansorge, I., Araujo, M., Aricò, S., Bailly, D., Barbière, J., … Gaill, F. (2020). A roadmap for using the UN decade of ocean science for sustainable development in support of science, policy, and action. *One Earth*, *2*(1), 34–42. https://doi.org/10.1016/j.oneear.2019.10.012

Claudet, J., Osenberg, C. W., Benedetti-Cecchi, L., Domenici, P., García-Charton, J.-A., Pérez-Ruzafa, Á., Badalamenti, F., Bayle-Sempere, J., Brito, A., Bulleri, F., Culioli, J.-M., Dimech, M., Falcón, J. M., Guala, I., Milazzo, M., Sánchez-Meca, J., Somerfield, P. J., Stobart, B., Vandeperre, F., … Planes, S. (2008). Marine reserves: Size and age do matter. *Ecology Letters*, *11*(5), 481–489. https://doi.org/10.1111/j.1461-0248.2008.01166.x

Clements, D. J., Sundin, J., Clark, T. D., & Jutfelt, F. (2020). An extreme decline effect in ocean acidification fish ecology. *EcoEvoRxiv*, https://doi.org/10.32942/OSF.IO/K9DBY

Consoli, P., Falautano, M., Sinopoli, M., Perzia, P., Canese, S., Esposito, V., Battaglia, P., Romeo, T., Andaloro, F., Galgani, F., & Castriota, L. (2018). Composition and abundance of benthic marine litter in a coastal area of the central Mediterranean Sea. *Marine Pollution Bulletin*, *136*, 243–247. https://doi.org/10.1016/j.marpolbul.2018.09.033

Cooke, S. J., Brownscombe, J. W., Raby, G. D., Broell, F., Hinch, S. G., Clark, T. D., & Semmens, J. M. (2016). Remote bioenergetics measurements in wild fish: Opportunities and challenges. *Comparative Biochemistry and Physiology—Part A: Molecular and Integrative Physiology*, *202*, 23–37. https://doi.org/10.1016/j.cbpa.2016.03.022

Cooke, S. J., Hinch, S. G., Wikelski, M., Andrews, R. D., Kuchel, L. J., Wolcott, T. G., & Butler, P. J. (2004). Biotelemetry: A mechanistic approach to ecology. *Trends in Ecology & Evolution*, *19*, 334–343.

Costanza, R., Andrade, F., Antunes, P., van den Belt, M., Boersma, D., Boesch, D. F., Catarino, F., Hanna, S., Limburg, K., Low, B., Molitor, M., Pereira, J. G., Rayner, S., Santos, R., Wilson, J., & Young, M. (1998). Principles for sustainable governance of the oceans. *Science*, *281*(5374), 198–199. https://doi.org/10.1126/science.281.5374.198

Costello, C., Rassweiler, A., Siegel, D., De Leo, G., Micheli, F., & Rosenberg, A. (2010). The value of spatial information in MPA network design. *Proceedings of the National Academy of Sciences of the United States of America*, *107*(43), 18294–18299. https://doi.org/10.1073/pnas.0908057107

Costello, C., Cao, L., Gelcich, S., Cisneros-Mata, M. Á., Free, C. M., Froehlich, H. E., Golden, C. D., Ishimura, G., Maier, J., Macadam-Somer, I., Mangin, T., Melnychuk, M. C., Miyahara, M., de Moor, C. L., Naylor, R., Nøstbakken, L., Ojea, E., O'Reilly, E., Parma, A. M., … Lubchenco, J. (2020). The future of food from the sea. *Nature*, *588*(7836), 95–100. https://doi.org/10.1038/s41586-020-2616-y

Cox, K., Brennan, L. P., Gerwing, T. G., Dudas, S. E., & Juanes, F. (2018). Sound the alarm: A meta-analysis on the effect of aquatic noise on fish behavior and physiology. *Global Change Biology*, *24*(7), 3105–3116. https://doi.org/10.1111/gcb.14106

Crear, D., Lawson, D., Seminoff, J., Eguchi, T., LeRoux, R., & Lowe, C. (2016). Seasonal shifts in the movement and distribution of green sea turtles *Chelonia mydas* in response to anthropogenically altered water temperatures. *Marine Ecology Progress Series*, *548*, 219–232. https://doi.org/10.3354/meps11696

Crossin, G. T., Heupel, M. R., Holbrook, C. M., Hussey, N. E., Lowerre-Barbieri, S. K., Nguyen, V. M., Raby, G. D., & Cooke, S. J. (2017). Acoustic telemetry and fisheries management. *Ecological Applications*, *27*(4), 1031–1049. https://doi.org/10.1002/eap.1533

Curtis, J. M., Johnson, M. W., Diamond, S. L., & Stunz, G. W. (2015). Quantifying delayed mortality from barotrauma impairment in discarded red snapper using acoustic telemetry. *Marine and Coastal Fisheries*, *7*(1), 434–449. https://doi.org/10.1080/19425120.2015.1074968

Curtis, T. H., Parkyn, D. C., & Burgess, G. H. (2013). Use of human-altered habitats by bull sharks in a Florida nursery area. *Marine and Coastal Fisheries*, *5*(1), 28–38. https://doi.org/10.1080/19425120.2012.756438

Dahl, K. A., & Patterson, W. F. (2020). Movement, home range, and depredation of invasive lionfish revealed by fine-scale acoustic telemetry in the northern Gulf of Mexico. *Marine Biology*, *167*(8), 111. https://doi.org/10.1007/s00227-020-03728-4

Daly, R., Daly, C., Gray, A., Peel, L., Gordon, L., Lea, J., Clarke, C., & Weng, K. (2020). Investigating the efficacy of a proposed marine protected area for the endangered humphead wrasse *Cheilinus undulatus* at a remote island group in Seychelles. *Endangered Species Research*, *42*, 7–20. https://doi.org/10.3354/esr01035

D'Anna, G., Giacalone, V. M., Pipitone, C., & Badalamenti, F. (2011). Movement pattern of white seabream, *Diplodus sargus* (L., 1758) (Osteichthyes, Sparidae) acoustically tracked in an artificial reef area. *Italian Journal of Zoology*, *78*(2), 255–263. https://doi.org/10.1080/11250000903464059

Dannheim, J., Bergström, L., Birchenough, S. N. R., Brzana, R., Boon, A. R., Coolen, J. W. P., Dauvin, J.-C., De Mesel, I., Derweduwen, J., Gill, A. B., Hutchison, Z. L., Jackson, A. C., Janas, U., Martin, G., Raoux, A., Reubens, J., Rostin, L., Vanaverbeke, J., Wilding, T. A., … Degraer, S. (2020). Benthic effects of offshore renewables: Identification of knowledge gaps and urgently needed research. *ICES Journal of Marine Science*, *77*(3), 1092–1108. https://doi.org/10.1093/icesjms/fsz018

Danylchuk, A. J., Cooke, S. J., Goldberg, T. L., Suski, C. D., Murchie, K. J., Danylchuk, S. E., Shultz, A. D., Haak, C. R., Brooks, E. J., Oronti, A., Koppelman, J. B., & Philipp, D. P. (2011). Aggregations and offshore movements as indicators of spawning activity of bonefish (*Albula vulpes*) in The Bahamas. *Marine Biology*, *158*(9), 1981–1999. https://doi.org/10.1007/s00227-011-1707-6

Danylchuk, A. J., Danylchuk, S. E., Cooke, S. J., Goldberg, T. L., Koppelman, J. B., & Philipp, D. P. (2007). Post-release mortality of bonefish, *Albula vulpes*, exposed to different handling practices during catch-and-release angling in Eleuthera, The Bahamas. *Fisheries Management and Ecology*, *14*(2), 149–154. https://doi.org/10.1111/j.1365-2400.2007.00535.x

Davidsen, J. G., Dong, H., Linné, M., Andersson, M. H., Piper, A., Prystay, T. S., Hvam, E. B., Thorstad, E. B., Whoriskey, F., Cooke, S. J., Sjursen, A. D., Rønning, L., Netland, T. C., & Hawkins, A. D. (2019). Effects of sound exposure from a seismic airgun on heart rate, acceleration and depth use in free-swimming Atlantic cod and saithe. *Conservation Physiology*, *7*(1), coz020. https://doi.org/10.1093/conphys/coz020 de Jong, K., Amorim, M. C. P., Fonseca, P. J., Fox, C. J., & Heubel, K. U. (2018). Noise can affect acoustic communication and subsequent spawning success in fish. *Environmental Pollution*, *237*, 814–823. https://doi.org/10.1016/j.envpol.2017.11.003

Degraer, S., Carey, D., Coolen, J., Hutchison, Z., Kerckhof, F., Rumes, B., & Vanaverbeke, J. (2020). Offshore wind farm artificial reefs affect ecosystem structure and functioning: A synthesis. *Oceanography*, *33*(4), 48–57. https://doi.org/10.5670/oceanog.2020.405

Deutsch, C., Ferrel, A., Seibel, B., Pörtner, H. O., & Huey, R. B. (2015). Climate change tightens a metabolic constraint on marine habitats. *Science*, *348*(6239), 1132–1135. https://doi.org/10.1126/science.aaa1605

Donaldson, M. R., Arlinghaus, R., Hanson, K. C., & Cooke, S. J. (2008). Enhancing catch-and-release science with biotelemetry. *Fish and Fisheries*, *9*(1), 79–105. https://doi.org/10.1111/j.1467-2979.2007.00265.x

Doumbouya, A., Camara, O. T., Mamie, J., Intchama, J. F., Jarra, A., Ceesay, S., Guèye, A., Ndiaye, D., Beibou, E., Padilla, A., & Belhabib, D. (2017). Assessing the effectiveness of monitoring control and surveillance of illegal fishing: The case of West Africa. *Frontiers in Marine Science*, *4*, 50. https://doi.org/10.3389/fmars.2017.00050

Duarte, C. M., Agusti, S., Barbier, E., Britten, G. L., Castilla, J. C., Gattuso, J.-P., Fulweiler, R. W., Hughes, T. P., Knowlton, N., Lovelock, C. E., Lotze, H. K., Predragovic, M., Poloczanska, E., Roberts, C., & Worm, B. (2020). Rebuilding marine life. *Nature*, *580*(7801), 39–51. https://doi.org/10.1038/s41586-020-2146-7

Duarte, C. M., Chapuis, L., Collin, S. P., Costa, D. P., Devassy, R. P., Eguiluz, V. M., Erbe, C., Gordon, T. A. C., Halpern, B. S., Harding, H. R., Havlik, M. N., Meekan, M., Merchant, N. D., Miksis-Olds, J. L., Parsons, M., Predragovic, M., Radford, A. N., Radford, C. A., Simpson, S. D., … Juanes, F. (2021). The soundscape of the Anthropocene ocean. *Science*, *371*, 6529. https://doi.org/10.1126/science.aba4658

Duarte, C. M., Holmer, M., Olsen, Y., Soto, D., Marbà, N., Guiu, J., Black, K., & Karakassis, I. (2009). Will the oceans help feed humanity? *BioScience*, *59*(11), 967–976. https://doi.org/10.1525/bio.2009.59.11.8

Duncan, E. M., Davies, A., Brooks, A., Chowdhury, G. W., Godley, B. J., Jambeck, J., Maddalene, T., Napper, I., Nelms, S. E., Rackstraw, C., & Koldewey, H. (2020). Message in a bottle: Open source technology to track the movement of plastic pollution. *PLoS ONE*, *15*(12), e0242459. https://doi.org/10.1371/journal.pone.0242459

Dwyer, R. G., Campbell, H. A., Pillans, R. D., Watts, M. E., Lyon, B. J., Guru, S. M., Dinh, M. N., Possingham, H. P., & Franklin, C. E. (2019). Using individual-based movement information to identify spatial conservation priorities for mobile species. *Conservation Biology*, *33*(6), 1426–1437. https://doi.org/10.1111/cobi.13328

Edwards, P., Zhang, W., Belton, B., & Little, D. C. (2019). Misunderstandings, myths and mantras in aquaculture: Its contribution to world food supplies has been systematically over reported. *Marine Policy*, *106*, 103547. https://doi.org/10.1016/j.marpol.2019.103547

Eggers, F., Moland Olsen, E., Moland, E., & Slotte, A. (2015). Individual habitat transitions of Atlantic herring *Clupea harengus* in a human-modified coastal system. *Marine Ecology Progress Series*, *520*, 245–256. https://doi.org/10.3354/meps11103

Ellis, R. D., Flaherty-Walia, K. E., Collins, A. B., Bickford, J. W., Boucek, R., Walters Burnsed, S. L., & Lowerre-Barbieri, S. K. (2019). Acoustic telemetry array evolution: From species- and project-specific designs to large-scale, multispecies, cooperative networks. *Fisheries Research*, *209*, 186–195. https://doi.org/10.1016/j.fishres.2018.09.015

Espinoza, M., Farrugia, T. J., & Lowe, C. G. (2011). Habitat use, movements and site fidelity of the gray smooth-hound shark (*Mustelus californicus*, Gill 1863) in a newly restored Southern California estuary. *Journal of Experimental Marine Biology and Ecology*, *401*(1–2), 63–74. https://doi.org/10.1016/j.jembe.2011.03.001

Espinoza, M., Heupel, M. R., Tobin, A. J., & Simpfendorfer, C. A. (2015). Movement patterns of silvertip sharks (*Carcharhinus albimarginatus*) on coral reefs. *Coral Reefs*, *34*(3), 807–821. https://doi.org/10.1007/s00338-015-1312-0

Estabrook, B., Ponirakis, D., Clark, C., & Rice, A. (2016). Widespread spatial and temporal extent of anthropogenic noise across the northeastern Gulf of Mexico shelf ecosystem. *Endangered Species Research*, *30*, 267–282. https://doi.org/10.3354/esr00743

Evans, K., Lea, M.-A., & Patterson, T. A. (2013). Recent advances in bio-logging science: Technologies and methods for understanding animal behaviour and physiology and their environments. *Deep Sea Research Part II: Topical Studies in Oceanography*, *88–89*, 1–6. https://doi.org/10.1016/j.dsr2.2012.10.005

Everett, A. G., Szedlmayer, S. T., & Gallaway, B. J. (2020). Movement patterns of red snapper *Lutjanus campechanus* based on acoustic telemetry around oil and gas platforms in the Northern Gulf of Mexico. *Marine Ecology Progress Series*, *649*, 155–173. https://doi.org/10.3354/meps13448

FAO (2015). Practical guidelines for the use of artificial reefs in the Mediterranean and the Black Sea. In G. Fabi, G. Scarcella, A. Spagnolo, S. A. Bortone, E. Charbonnel, J. J. Goutayer, N. Haddad, A. Lök, & M. Trommelen (Eds.), *Studies and reviews*. GFCM, No. 96.

FAO, The State of World Fisheries and Aquaculture. (2021). Food and Agriculture Organization of the United Nations, Rome.

Farrugia, T. J., Espinoza, M., & Lowe, C. G. (2011). Abundance, habitat use and movement patterns of the shovelnose guitarfish (*Rhinobatos productus*) in a restored Southern California estuary. *Marine and Freshwater Research*, *62*(6), 648. https://doi.org/10.1071/MF10173

Ferter, K., Hartmann, K., Kleiven, A. R., Moland, E., & Olsen, E. M. (2015). Catch-and-release of Atlantic cod (*Gadus morhua*): Post-release behaviour of acoustically pretagged fish in a natural marine environment. *Canadian Journal of Fisheries and Aquatic Sciences*, *72*(2), 252–261. https://doi.org/10.1139/cjfas-2014-0290

Ferter, K., Rikardsen, A. H., Evensen, T. H., Svenning, M.-A., & Tracey, S. R. (2017). Survival of Atlantic halibut (*Hippoglossus hippoglossus*) following catch-and-release angling. *Fisheries Research*, *186*, 634–641. https://doi.org/10.1016/j.fishres.2016.05.022

Fewtrell, J. L., & McCauley, R. D. (2012). Impact of air gun noise on the behaviour of marine fish and squid. *Marine Pollution Bulletin*, *64*(5), 984–993. https://doi.org/10.1016/j.marpolbul.2012.02.009

Fillinger, L., Sutin, A., & Sedunov, A. (2011). Acoustic ship signature measurements by cross-correlation method. *The Journal of the Acoustical Society of America*, *129*(2), 774–778. https://doi.org/10.1121/1.3365315

Filous, A., Friedlander, A. M., Griffin, L., Lennox, R. J., Danylchuk, A. J., Mereb, G., & Golbuu, Y. (2020). Movements of juvenile yellowfin tuna (*Thunnus albacares*) within the coastal FAD network adjacent to the Palau National Marine Sanctuary: Implications for local fisheries development. *Fisheries Research*, *230*, 105688. https://doi.org/10.1016/j.fishres.2020.105688

Filous, A., Lennox, R. J., Clua, E. E. G., & Danylchuk, A. J. (2019). Fisheries selectivity and annual exploitation of the principal species harvested in a data-limited artisanal fishery at a remote atoll in French Polynesia. *Ocean & Coastal Management*, *178*, 104818. https://doi.org/10.1016/j.ocecoaman.2019.104818

Filous, A., Lennox, R. J., Raveino, R., Friedlander, A. M., Clua, E. E. G., Cooke, S. J., & Danylchuk, A. J. (2020). The spawning migrations of an exploited *Albulid* in the tropical Pacific: Implications for conservation and community-based management. *Environmental Biology of Fishes*, *103*(9), 1013–1031. https://doi.org/10.1007/s10641-020-00996-3

Flávio, H., Aarestrup, K., Jepsen, N., & Koed, A. (2019). Naturalised Atlantic salmon smolts are more likely to reach the sea than wild smolts in a lowland fjord. *River Research and Applications*, *35*(3), 216–223. https://doi.org/10.1002/rra.3400

Freedman, R., Whitcraft, C., & Lowe, C. (2015). Connectivity and movements of juvenile predatory fishes between discrete restored estuaries in Southern California. *Marine Ecology Progress Series*, *520*, 191–201. https://doi.org/10.3354/meps11109

Freitas, C., Olsen, E. M., Knutsen, H., Albretsen, J., & Moland, E. (2016). Temperature-associated habitat selection in a cold-water marine fish. *Journal of Animal Ecology*, *85*(3), 628–637. https://doi.org/10.1111/1365-2656.12458

Friedl, S. E., Buckel, J. A., Hightower, J. E., Scharf, F. S., & Pollock, K. H. (2013). Telemetry-based mortality estimates of juvenile spot in two North Carolina estuarine creeks. *Transactions of the American Fisheries Society*, *142*(2), 399–415. https://doi.org/10.1080/00028487.2012.730108

Friess, C., Lowerre-Barbieri, S. K., Poulakis, G. R., Hammerschlag, N., Gardiner, J. M., Kroetz, A. M., Bassos-Hull, K., Bickford, J. W., Bohaboy, E. C., Ellis, R. D., Menendez, H., Patterson, W. F., Price, M. L., Rehage, J. S., Shea, C., Smukall, M. J., Walters Burnsed, S. L., Wilkinson, K. A., Young, J., … Griffin, L. P. (2021). Regional-scale variability in the movement ecology of marine fishes revealed by an integrative acoustic tracking network. *Marine Ecology Progress Series*, *663*, 157–177. https://doi.org/10.3354/meps13637

Fujioka, K., Fukuda, H., Tei, Y., Okamoto, S., Kiyofuji, H., Furukawa, S., Takagi, J., Estess, E., Farwell, C. J., Fuller, D. W., Suzuki, N., Ohshimo, S., & Kitagawa, T. (2018). Spatial and temporal variability in the trans-Pacific migration of Pacific bluefin tuna (*Thunnus orientalis*) revealed by archival tags. *Progress in Oceanography*, *162*, 52–65. https://doi.org/10.1016/j.pocean.2018.02.010

Getz, E. T., & Kline, R. J. (2019). Utilizing accelerometer telemetry tags to compare red snapper (*Lutjanus campechanus* [Poey, 1860]) behavior on artificial and natural reefs. *Journal of Experimental Marine Biology and Ecology*, *519*, 151202. https://doi.org/10.1016/j.jembe.2019.151202

Gill, A., Degraer, S., Lipsky, A., Mavraki, N., Methratta, E., & Brabant, R. (2020). Setting the context for offshore wind development effects on fish and fisheries. *Oceanography*, *33*(4), 118–127. https://doi.org/10.5670/oceanog.2020.411

Gill, A. B. (2005). Offshore renewable energy: Ecological implications of generating electricity in the coastal zone. *Journal of Applied Ecology*, *42*(4), 605–615. https://doi.org/10.1111/j.1365-2664.2005.01060.x

Goñi, R., Hilborn, R., Díaz, D., Mallol, S., & Adlerstein, S. (2010). Net contribution of spillover from a marine reserve to fishery catches. *Marine Ecology Progress Series*, *400*, 233–243. https://doi.org/10.3354/meps08419

Grafton, R. Q., & Kompas, T. (2005). Uncertainty and the active adaptive management of marine reserves. *Marine Policy*, *29*(5), 471–479. https://doi.org/10.1016/j.marpol.2004.07.006

Green, A. L., Maypa, A. P., Almany, G. R., Rhodes, K. L., Weeks, R., Abesamis, R. A., Gleason, M. G., Mumby, P. J., & White, A. T. (2015). Larval dispersal and movement patterns of coral reef fishes, and implications for marine reserve network design. *Biological Reviews*, *90*(4), 1215–1247. https://doi.org/10.1111/brv.12155

Grüss, A., Kaplan, D. M., Guénette, S., Roberts, C. M., & Botsford, L. W. (2011). Consequences of adult and juvenile movement for marine protected areas. *Biological Conservation*, *144*(2), 692–702. https://doi.org/10.1016/j.biocon.2010.12.015

Hall-Spencer, J. M., Rodolfo-Metalpa, R., Martin, S., Ransome, E., Fine, M., Turner, S. M., Rowley, S. J., Tedesco, D., & Buia, M. C. (2008). Volcanic carbon dioxide vents show ecosystem effects of ocean acidification. *Nature*, *454*(7200), 96–99. https://doi.org/10.1038/nature07051

Halouani, G., Villanueva, C.-M., Raoux, A., Dauvin, J. C., Ben Rais Lasram, F., Foucher, E., Le Loc'h, F., Safi, G., Araignous, E., Robin, J. P., & Niquil, N. (2020). A spatial food web model to investigate potential spillover effects of a fishery closure in an offshore wind farm. *Journal of Marine Systems*, *212*, 103434. https://doi.org/10.1016/j.jmarsys.2020.103434

Haulsee, D. E., Breece, M. W., Miller, D. C., Wetherbee, B. M., Fox, D. A., & Oliver, M. J. (2015). Habitat selection of a coastal shark species estimated from an autonomous underwater vehicle. *Marine Ecology Progress Series*, *528*, 277–288.

Hays, G. C., Bailey, H., Bograd, S. J., Bowen, W. D., Campagna, C., Carmichael, R. H., Casale, P., Chiaradia, A., Costa, D. P., Cuevas, E., Nico de Bruyn, P. J., Dias, M. P., Duarte, C. M., Dunn, D. C., Dutton, P. H., Esteban, N., Friedlaender, A., Goetz, K. T., Godley, B. J., … Sequeira, A. M. M. (2019). Translating marine animal tracking data into conservation policy and management. *Trends in Ecology & Evolution*, *34*(5), 459–473. https://doi.org/10.1016/j.tree.2019.01.009

Hazen, E. L., Jorgensen, S., Rykaczewski, R. R., Bograd, S. J., Foley, D. G., Jonsen, I. D., Shaffer, S. a., Dunne, J. P., Costa, D. P., Crowder, L. B., & Block, B. a. (2012). Predicted habitat shifts of Pacific top predators in a changing climate. *Nature Climate Change*, *3*(3), 234–238. https://doi.org/10.1038/nclimate1686

Heino, M., Díaz Pauli, B., & Dieckmann, U. (2015). Fisheries-induced evolution. *Annual Review of Ecology, Evolution, and Systematics*, *46*(1), 461–480. https://doi.org/10.1146/annurev-ecolsys-112414-054339

Hellström, G., Klaminder, J., Jonsson, M., Fick, J., & Brodin, T. (2016). Upscaling behavioural studies to the field using acoustic telemetry. *Aquatic Toxicology*, *170*, 384–389. https://doi.org/10.1016/j.aquatox.2015.11.005

Heupel, M. R., Semmens, J. M., & Hobday, A. J. (2006). Automated acoustic tracking of aquatic animals: Scales, design and deployment of listening station arrays. *Marine and Freshwater Research*, *57*, 1–13. https://doi.org/10.1071/MF05091

Heupel, M. R., & Simpfendorfer, C. A. (2002). Estimation of mortality of juvenile blacktip sharks, *Carcharhinus limbatus*, within a nursery area using telemetry data. *Canadian Journal of Fisheries and Aquatic Sciences*, *59*(4), 624–632. https://doi.org/10.1139/f02-036

Hightower, J. E., Jackson, J. R., & Pollock, K. H. (2001). Use of telemetry methods to estimate natural and fishing mortality of striped bass in Lake Gaston, North Carolina. *Transactions of the American Fisheries Society*, *130*(4), 557–567. https://doi.org/10.1577/1548-8659(2001)130<0557:UOTMTE>2.0.CO;2

Hilborn, R., Hively, D. J., Loke, N. B., Moor, C. L., Kurota, H., Kathena, J. N., Mace, P. M., Minto, C., Parma, A. M., Quiroz, J., & Melnychuk, M. C. (2021). Global status of groundfish stocks. *Fish and Fisheries*, *22*(5), 911–928. https://doi.org/10.1111/faf.12560

Hildebrand, J. (2016). Characterizing ambient noise in marine and terrestrial settings. *The Journal of the Acoustical Society of America*, *139*(4), 2089. https://doi.org/10.1121/1.4950197

Hindell, J. S. (2007). Determining patterns of use by black bream *Acanthopagrus butcheri* (Munro, 1949) of re-established habitat in a south-eastern Australian estuary. *Journal of Fish Biology*, *71*(5), 1331–1346. https://doi.org/10.1111/j.1095-8649.2007.01594.x

Howell, L., LaRue, M., & Flanagan, S. P. (2021). Environmental DNA as a tool for monitoring Antarctic vertebrates. *New Zealand Journal of Zoology*, *48*(3–4), 245–262. https://doi.org/10.1080/03014223.2021.1900299

Hubert, J., Campbell, J. A., & Slabbekoorn, H. (2020). Effects of seismic airgun playbacks on swimming patterns and behavioural states of Atlantic cod in a net pen. *Marine Pollution Bulletin*, *160*, 111680. https://doi.org/10.1016/j.marpolbul.2020.111680

Hussey, N. E., Hedges, K. J., Barkley, A. N., Treble, M. A., Peklova, I., Webber, D. M., Ferguson, S. H., Yurkowski, D. J., Kessel, S. T., Bedard, J. M., & Fisk, A. T. (2017). Movements of a deep-water fish: Establishing marine fisheries management boundaries in coastal Arctic waters. *Ecological Applications*, *27*(3), 687–704. https://doi.org/10.1002/eap.1485

Hussey, N. E., Kessel, S. T., Aarestrup, K., Cooke, S. J., Cowley, P. D., Fisk, A. T., Harcourt, R. G., Holland, K. N., Iverson, S. J., Kocik, J. F., Flemming, J. E. M., & Whoriskey, F. G. (2015). Aquatic animal telemetry: A panoramic window into the underwater world. *Science*, *348*(6240), 1255642. https://doi.org/10.1126/science.1255642

Huveneers, C., Jaine, F. R. A., Barnett, A., Butcher, P. A., Clarke, T. M., Currey-Randall, L. M., Dwyer, R. G., Ferreira, L. C., Gleiss, A. C., Hoenner, X., Ierodiaconou, D., Lédée, E. J. I., Meekan, M. G., Pederson, H., Rizzari, J. R., van Ruth, P. D., Semmens, J. M., Taylor, M. D., Udyawer, V., … Harcourt, R. (2021). The power of national acoustic tracking networks to assess the impacts of human activity on marine organisms during the COVID-19 pandemic. *Biological Conservation*, *256*, 108995. https://doi.org/10.1016/j.biocon.2021.108995

Ingram, E. C., Cerrato, R. M., Dunton, K. J., & Frisk, M. G. (2019). Endangered Atlantic sturgeon in the New York wind energy area: Implications of future development in an offshore wind energy site. *Scientific Reports*, *9*(1), 12432. https://doi.org/10.1038/s41598-019-48818-6

IPCC. (2019). Summary for policymakers. In H.-O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, & N. M. Weyer (Eds.), *IPCC special report on the ocean and cryosphere in a changing climate*.

Itakura, H., O'Brien, M. H. P., & Secor, D. (2021). Tracking oxy-thermal habitat compression encountered by Chesapeake Bay striped bass through acoustic telemetry. *ICES Journal of Marine Science*, *78*(3), 1049–1062. https://doi.org/10.1093/icesjms/fsab009

Ivanova, S. V., Kessel, S. T., Espinoza, M., McLean, M. F., O'Neill, C., Landry, J., Hussey, N. E., Williams, R., Vagle, S., & Fisk, A. T. (2020). Shipping alters the movement and behavior of Arctic cod (*Boreogadus saida*), a keystone fish in Arctic marine ecosystems. *Ecological Applications*, *30*(3), e02050. https://doi.org/10.1002/eap.2050

Iverson, S. J., Fisk, A. T., Hinch, S. G., Mills Flemming, J., Cooke, S. J., & Whoriskey, F. G. (2019). The Ocean Tracking Network: Advancing frontiers in aquatic science and management. *Canadian Journal of Fisheries and Aquatic Sciences*, *76*(7), 1041–1051. https://doi.org/10.1139/cjfas-2018-0481

Jambeck, J. R., Geyer, R., Wilcox, C., Siegler, T. R., Perryman, M., Andrady, A., Narayan, R., & Law, K. L. (2015). Plastic waste inputs from land into the ocean. *Science*, *347*(6223), 768–771. https://doi.org/10.1126/science.1260352

Jirik, K. E., & Lowe, C. G. (2012). An elasmobranch maternity ward: Female round stingrays *Urobatis halleri* use warm, restored estuarine habitat during gestation. *Journal of Fish Biology*, *80*(5), 1227–1245. https://doi.org/10.1111/j.1095-8649.2011.03208.x

Jørgensen, C., Enberg, K., Dunlop, E. S., Arlinghaus, R., Boukal, D. S., Brander, K., Ernande, B., Gårdmark, A. G., Johnston, F., Matsumura, S., Pardoe, H., Raab, K., Silva, A., Vainikka, A., Dieckmann, U., Heino, M., & Rijnsdorp, A. D. (2007). Managing evolving fish stocks. *Science*, *318*(5854), 1247–1248. https://doi.org/10.1126/science.1148089

Kasumyan, A. O. (2001). Effects of chemical pollutants on foraging behavior and sensitivity of fish to food stimuli. *Journal of Ichthyology*, *41*(1), 76–87.

Katzner, T. E., & Arlettaz, R. (2020). Evaluating contributions of recent tracking-based animal movement ecology to conservation management. *Frontiers in Ecology and Evolution*, *7*, 519. https://doi.org/10.3389/fevo.2019.00519

Kawabata, Y., Asami, K., Kobayashi, M., Sato, T., Okuzawa, K., Yamada, H., Yoseda, K., & Arai, N. (2011). Effect of shelter acclimation on the post-release movement and putative predation mortality of hatchery-reared black-spot tuskfish *Choerodon schoenleinii*, determined by acoustic telemetry. *Fisheries Science*, *77*(3), 345–355. https://doi.org/10.1007/s12562-011-0351-x

Kawabata, Y., Okuyama, J., Mitamura, H., Asami, K., Yoseda, K., & Arai, N. (2007). Post-release movement and diel activity patterns of hatchery-reared and wild black-spot tuskfish *Choerodon schoenleinii* determined by ultrasonic telemetry. *Fisheries Science*, *73*(5), 1147–1154. https://doi.org/10.1111/j.1444-2906.2007.01446.x

Keller, K., Smith, J. A., Lowry, M. B., Taylor, M. D., & Suthers, I. M. (2017). Multispecies presence and connectivity around a designed artificial reef. *Marine and Freshwater Research*, *68*(8), 1489. https://doi.org/10.1071/MF16127

Kennicutt, M. C., Chown, S. L., Cassano, J. J., Liggett, D., Massom, R., Peck, L. S., Rintoul, S. R., Storey, J. W. V., Vaughan, D. G., Wilson, T. J., & Sutherland, W. J. (2014). Polar research: Six priorities for Antarctic science. *Nature*, *512*(7512), 23–25. https://doi.org/10.1038/512023a

Koeck, B., Alós, J., Caro, A., Neveu, R., Crec'hriou, R., Saragoni, G., & Lenfant, P. (2013). Contrasting fish behavior in artificial seascapes with implications for resources conservation. *PLoS ONE*, *8*(7), e69303. https://doi.org/10.1371/journal.pone.0069303

Kontopoulos, I., Chatzikokolakis, K., Zissis, D., Tserpes, K., & Spiliopoulos, G. (2020). Real-time maritime anomaly detection: Detecting intentional AIS switch-off. *International Journal of Big Data Intelligence*, *7*(2), 85. https://doi.org/10.1504/IJBDI.2020.107375

Kristensen, L. D., Støttrup, J. G., Svendsen, J. C., Stenberg, C., Højbjerg Hansen, O. K., & Grønkjaer, P. (2017). Behavioural changes of Atlantic cod (*Gadus morhua*) after marine boulder reef restoration: Implications for coastal habitat management and Natura 2000 areas. *Fisheries Management and Ecology*, *24*(5), 353–360. https://doi.org/10.1111/fme.12235

Kristensen, M. L., Righton, D., del Villar-Guerra, D., Baktoft, H., & Aarestrup, K. (2018). Temperature and depth preferences of adult sea trout *Salmo trutta* during the marine migration phase. *Marine Ecology Progress Series*, *599*, 209–224. https://doi.org/10.3354/meps12618

Kroeker, K. J., Kordas, R. L., Crim, R., Hendriks, I. E., Ramajo, L., Singh, G. S., Duarte, C. M., & Gattuso, J. P. (2013). Impacts of ocean acidification on marine organisms: Quantifying sensitivities and interaction with warming. *Global Change Biology*, *19*(6), 1884–1896. https://doi.org/10.1111/gcb.12179

Kroodsma, D. A., Mayorga, J., Hochberg, T., Miller, N. A., Boerder, K., Ferretti, F., Wilson, A., Bergman, B., White, T. D., Block, B. A., Woods, P., Sullivan, B., Costello, C., & Worm, B. (2018). Tracking the global footprint of fisheries. *Science*, *359*(6378), 904–908. https://doi.org/10.1126/science.aao5646

Kudryavtsev, A. A., Luginets, K. P., & Mashoshin, A. I. (2003). Amplitude modulation of underwater noise produced by seagoing vessels. *Acoustical Physics*, *49*(2), 184–188. https://doi.org/10.1134/1.1560380

Laffoley, D., Baxter, J. M., Amon, D. J., Currie, D. E. J., Downs, C. A., Hall-Spencer, J. M., Harden-Davies, H., Page, R., Reid, C. P., Roberts, C. M., Rogers, A., Thiele, T., Sheppard, C. R. C., Sumaila, R. U., & Woodall, L. C. (2020). Eight urgent, fundamental and simultaneous steps needed to restore ocean health, and the consequences for humanity and the planet of inaction or delay. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *30*(1), 194–208. https://doi.org/10.1002/aqc.3182

Larsson, D. G. J., de Pedro, C., & Paxeus, N. (2007). Effluent from drug manufactures contains extremely high levels of pharmaceuticals. *Journal of Hazardous Materials*, *148*(3), 751–755. https://doi.org/10.1016/j.jhazmat.2007.07.008

Le Quesne, W. J. F., & Codling, E. A. (2009). Managing mobile species with MPAs: The effects of mobility, larval dispersal, and fishing mortality on closure size. *ICES Journal of Marine Science*, *66*(1), 122–131. https://doi.org/10.1093/icesjms/fsn202

Lea, J. S. E., Humphries, N. E., von Brandis, R. G., Clarke, C. R., & Sims, D. W. (2016). Acoustic telemetry and network analysis reveal the space use of multiple reef predators and enhance marine protected area design. *Proceedings of the Royal Society B: Biological Sciences*, *283*(1834), 20160717. https://doi.org/10.1098/rspb.2016.0717

Lédée, E. J. I., Heupel, M. R., Taylor, M. D., Harcourt, R. G., Jaine, F. R. A., Huveneers, C., Udyawer, V., Campbell, H. A., Babcock, R. C., Hoenner, X., Barnett, A., Braccini, M., Brodie, S., Butcher, P. A., Cadiou, G., Dwyer, R. G., Espinoza, M., Ferreira, L. C., Fetterplace, L., … Simpfendorfer, C. A. (2021). Continental-scale acoustic telemetry and network analysis reveal new insights into stock structure. *Fish and Fisheries*, *22*(5), 987–1005. https://doi.org/10.1111/faf.12565

Lee, K. A., Huveneers, C., Peddemors, V., Boomer, A., & Harcourt, R. G. (2015). Born to be free? Assessing the viability of releasing captive-bred wobbegongs to restock depleted populations. *Frontiers in Marine Science*, *2*, 18. https://doi.org/10.3389/fmars.2015.00018

Lennox, R. J., Aarestrup, K., Cooke, S. J., Cowley, P. D., Deng, Z. D., Fisk, A. T., Harcourt, R. G., Heupel, M., Hinch, S. G., Holland, K. N., Hussey, N. E., Iverson, S. J., Kessel, S. T., Kocik, J. F., Lucas, M. C., Flemming, J. M., Nguyen, V. M., Stokesbury, M. J. W., Vagle, S., … Young, N. (2017). Envisioning the future of aquatic animal tracking: Technology, science, and application. *BioScience*, *67*(10), 884–896. https://doi.org/10.1093/biosci/bix098

Lewison, R. L., Crowder, L. B., Read, A. J., & Freeman, S. A. (2004). Understanding impacts of fisheries bycatch on marine megafauna. *Trends in Ecology & Evolution*, *19*(11), 598–604. https://doi.org/10.1016/j.tree.2004.09.004

Li, W. C., Tse, H. F., & Fok, L. (2016). Plastic waste in the marine environment: A review of sources, occurrence and effects. *Science of the Total Environment*, *566*, 333–349. https://doi.org/10.1016/j.scitotenv.2016.05.084

Linares, C., Vidal, M., Canals, M., Kersting, D. K., Amblas, D., Aspillaga, E., Dı, D., Garrabou, J., Hereu, B., Ballesteros, E., Navarro, L., Teixido, N., Cebrián, E., Delgado-Huertas, A., Díaz, D., Garrabou, J., Hereu, B., Navarro, L., Teixidó, N., & Ballesteros, E. (2015). Persistent natural acidification drives major distribution shifts in marine benthic ecosystems. *Proceedings of the Royal Society B: Biological Sciences*, *282*(1818), 20150587. https://doi.org/10.1098/rspb.2015.0587

Logan, R., & Lowe, C. (2018). Residency and inter-reef connectivity of three gamefishes between natural reefs and a large mitigation artificial reef. *Marine Ecology Progress Series*, *593*, 111–126. https://doi.org/10.3354/meps12527

Long, T., Widjaja, S., Wirajuda, H., & Juwana, S. (2020). Approaches to combatting illegal, unreported and unregulated fishing. *Nature Food*, *1*(7), 389–391. https://doi.org/10.1038/s43016-020-0121-y

Longcore, T., & Rich, C. (2004). Ecological light pollution. *Frontiers in Ecology and the Environment*, *2*(4), 191–198. https://doi.org/10.1890/1540-9295(2004)002[0191:ELP]2.0.CO;2

Lowerre-Barbieri, S., DeCelles, G., Pepin, P., Catalán, I. A., Muhling, B., Erisman, B., Cadrin, S. X., Alós, J., Ospina-Alvarez, A., Stachura, M. M., Tringali, M. D., Burnsed, S. W., & Paris, C. B. (2017). Reproductive resilience: A paradigm shift in understanding spawner-recruit systems in exploited marine fish. *Fish and Fisheries*, *18*(2), 285–312. https://doi.org/10.1111/faf.12180

Lowerre-Barbieri, S. K., Friess, C., Griffin, L. P., Morley, D., Skomal, G. B., Bickford, J. W., Hammerschlag, N., Rider, M. J., Smukall, M. J., Zinnicq Bergmann, M. P. M., Guttridge, T. L., Kroetz, A. M., Grubbs, R. D., Gervasi, C. L., Rehage, J. S., Poulakis, G. R., Bassos-Hull, K., Gardiner, J. M., Casselberry, G. A., … Brownscombe, J. W. (2021). Movescapes and eco-evolutionary movement strategies in marine fish: Assessing a connectivity hotspot. *Fish and Fisheries*, *22*(6), 1321–1344. https://doi.org/10.1111/faf.12589

Lowerre-Barbieri, S. K., Kays, R., Thorson, J. T., & Wikelski, M. (2019). The ocean's movescape: Fisheries management in the bio-logging decade (2018–2028). *ICES Journal of Marine Science*, *76*(2), 477–488. https://doi.org/10.1093/icesjms/fsy211

Lowerre-Barbieri, S. K., Vose, F. E., & Whittington, J. A. (2003). Catch-and-release fishing on a spawning aggregation of common snook: Does it affect reproductive output? *Transactions of the American Fisheries Society*, *132*(5), 940–952. https://doi.org/10.1577/T02-001

Madrak, S. V., Lewison, R. L., Seminoff, J. A., & Eguchi, T. (2016). Characterizing response of East Pacific green turtles to changing temperatures: Using acoustic telemetry in a highly urbanized environment. *Animal Biotelemetry*, *4*(1), 22. https://doi.org/10.1186/s40317-016-0114-7

Marangoni, L. F. B., Davies, T., Smyth, T., Rodríguez, A., Hamann, M., Duarte, C., Pendoley, K., Berge, J., Maggi, E., & Levy, O. (in press). Impacts of Artificial Light at Night (ALAN) in marine ecosystems – A review. *Global Change Biology*. https://doi.org/10.1111/gcb.16264

Marshell, A., Mills, J. S., Rhodes, K. L., & McIlwain, J. (2011). Passive acoustic telemetry reveals highly variable home range and movement patterns among unicornfish within a marine reserve. *Coral Reefs*, *30*(3), 631–642. https://doi.org/10.1007/s00338-011-0770-2

Martin, A., Boyd, P., Buesseler, K., Cetinic, I., Claustre, H., Giering, S., Henson, S., Irigoien, X., Kriest, I., Memery, L., & Robinson, C. (2020). The oceans' twilight zone must be studied now, before it is too late. *Nature*, *580*, 26–28.

Martín, G., Espinoza, M., Heupel, M., & Simpfendorfer, C. A. (2020). Estimating marine protected area network benefits for reef sharks. *Journal of Applied Ecology*, *57*(10), 1969–1980. https://doi.org/10.1111/1365-2664.13706

Masmitja, I., Navarro, J., Gomariz, S., Aguzzi, J., Kieft, B., O'Reilly, T., & Katija, K. (2020). Mobile robotic platforms for the acoustic tracking of deep-sea demersal fishery resources. *Science Robotics*, *5*, eabc3701.

Matley, J. K., Klinard, N. V., Barbosa Martins, A. P., Aarestrup, K., Aspillaga, E., Cooke, S. J., Cowley, P. D., Heupel, M. R., Lowe, C. G., Lowerre-Barbieri, S. K., Mitamura, H., Moore, J.-S., Simpfendorfer, C. A., Stokesbury, M. J. W., Taylor, M. D., Thorstad, E. B., Vandergoot, C. S., & Fisk, A. T. (2022). Global trends in aquatic animal tracking with acoustic telemetry. *Trends in Ecology & Evolution*, *37*(1), 79–94. https://doi.org/10.1016/j.tree.2021.09.001

Maxwell, S. M., Gjerde, K. M., Conners, M. G., & Crowder, L. B. (2020). Mobile protected areas for biodiversity on the high seas. *Science*, *367*, 252–254.

McCauley, D. J., Woods, P., Sullivan, B., Bergman, B., Jablonicky, C., Roan, A., Hirshfield, M., Boerder, K., & Worm, B. (2016). Ending hide and seek at sea. *Science*, *351*(6278), 1148–1150. https://doi.org/10.1126/science.aad5686

McCook, L. J., Ayling, T., Cappo, M., Choat, J. H., Evans, R. D., De Freitas, D. M., Heupel, M., Hughes, T. P., Jones, J. G., Mapstone, B., Marshall, H., Mills, M., Molloy, F. J., Pitcher, C. R., Pressey, R. L., Russ, G. R., Sutton, S., Sweatman, H., Tobin, R., … Williamson, D. H. (2010). Adaptive management of the Great Barrier Reef: A globally significant demonstration of the benefits of networks of marine reserves. *Proceedings of the National Academy of Sciences of the United States of America*, *107*(43), 18278–18285. https://doi.org/10.1073/pnas.0909335107

Meyer, C. G., Papastamatiou, Y. P., & Holland, K. N. (2007). Seasonal, diel, and tidal movements of green jobfish (*Aprion virescens*, Lutjanidae) at remote Hawaiian atolls: Implications for marine protected area design. *Marine Biology*, *151*(6), 2133–2143. https://doi.org/10.1007/s00227-007-0647-7

Moilanen, A., & Kujala, H. (2008). *Zonation spatial conservation planning framework and software* (User manual v. 2.0).

Montero-Serra, I., Edwards, M., & Genner, M. J. (2015). Warming shelf seas drive the subtropicalization of European pelagic fish communities. *Global Change Biology*, *21*(1), 144–153. https://doi.org/10.1111/gcb.12747

Morfin, M., Simon, J., Morandeau, F., Baulier, L., Méhault, S., & Kopp, D. (2019). Using acoustic telemetry to estimate post-release survival of undulate ray *Raja undulata* (Rajidae) in northeast Altantic. *Ocean & Coastal Management*, *178*, 104848. https://doi.org/10.1016/j.ocecoaman.2019.104848

Moser, M. L., & Lindley, S. T. (2007). Use of Washington estuaries by subadult and adult green sturgeon. *Environmental Biology of Fishes*, *79*(3–4), 243–253. https://doi.org/10.1007/s10641-006-9028-1

Moxham, E. J., Cowley, P. D., Bennett, R. H., & von Brandis, R. G. (2019). Movement and predation: A catch-and-release study on the acoustic tracking of bonefish in the Indian Ocean. *Environmental Biology of Fishes*, *102*(2), 365–381. https://doi.org/10.1007/s10641-019-00850-1

Munday, P. L., Dixson, D. L., McCormick, M. I., Meekan, M., Ferrari, M. C. O., & Chivers, D. P. (2010). Replenishment of fish populations is threatened by ocean acidification. *Proceedings of the National Academy of Sciences of the United States of America*, *107*(29), 12930–12934. https://doi.org/10.1073/pnas.1004519107

Munilla, I., Arcos, J. M., Oro, D., Álvarez, D., Leyenda, P. M., & Velando, A. (2011). Mass mortality of seabirds in the aftermath of the Prestige oil spill. *Ecosphere*, *2*(7), art83. https://doi.org/10.1890/ES11-00020.1

Nagelkerken, I., & Connell, S. D. (2015). Global alteration of ocean ecosystem functioning due to increasing human CO_2 emissions. *Proceedings of the National Academy of Sciences of the United States of America*, *112*(43), 13272–13277. https://doi.org/10.1073/pnas.1510856112

Nagelkerken, I., Russell, B. D., Gillanders, B. M., & Connell, S. D. (2016). Ocean acidification alters fish populations indirectly through habitat modification. *Nature Climate Change*, *6*(1), 89–93. https://doi.org/10.1038/nclimate2757

Nathan, R., Monk, C. T., Arlinghaus, R., Adam, T., Alós, J., Assaf, M., Baktoft, H., Beardsworth, C. E., Bertram, M. G., Bijleveld, A. I., Brodin, T., Brooks, J. L., Campos-Candela, A., Cooke, S. J., & Gjelland, K. Ø. (2022). Big-data approaches lead to an increased understanding of the ecology of animal movement. *Science*, *375*, eabg1780. http://doi.org/10.1126/science.abg1780

Nelson, T. R., & Powers, S. P. (2020). Estimates of red drum mortality via acoustic telemetry. *Marine and Coastal Fisheries*, *12*(1), 78–97. https://doi.org/10.1002/mcf2.10110

Nightingale, B., Longcore, T., & Simenstad, C. A. (2006). Artificial night lighting and fishes. In C. Rich & T. Longcore (Eds.), *Ecological consequences of artificial night lighting* (pp. 257–276). Island Press.

Nowacek, D. P., Clark, C. W., Mann, D., Miller, P. J., Rosenbaum, H. C., Golden, J. S., Jasny, M., Kraska, J., & Southall, B. L. (2015). Marine seismic surveys and ocean noise: Time for coordinated and prudent planning. *Frontiers in Ecology and the Environment*, *13*(7), 378–386. https://doi.org/10.1890/130286

Olsen, E. M., Heupel, M. R., Simpfendorfer, C. A., & Moland, E. (2012). Harvest selection on Atlantic cod behavioral traits: Implications for spatial management. *Ecology and Evolution*, *2*(7), 1549–1562. https://doi.org/10.1002/ece3.244

O'Neill, F. G., Feekings, J., Fryer, R. J., Fauconnet, L., & Afonso, P. (2019). Discard avoidance by improving fishing gear selectivity: Helping the fishing industry help itself. In S. Uhlmann, C. Ulrich, & S. Kennelly (Eds.), *The European landing obligation*. Springer.

O'Toole, A. C., Dechraoui Bottein, M. Y., Danylchuk, A. J., Ramsdell, J. S., & Cooke, S. J. (2012). Linking ciguatera poisoning to spatial ecology of fish: A novel approach to examining the distribution of biotoxin levels in the great barracuda by combining non-lethal blood sampling and biotelemetry. *Science of the Total Environment*, *427*, 98–105. https://doi.org/10.1016/j.scitotenv.2011.11.053

Özgül, A., Lök, A., Tansel Tanrıkul, T., & Alós, J. (2019). Home range and residency of *Scorpaena porcus* and *Scorpaena scrofa* in artificial reefs revealed by fine-scale acoustic tracking. *Fisheries Research*, *210*, 22–30. https://doi.org/10.1016/j.fishres.2018.10.008

Özgül, A., Lök, A., Ulaş, A., Düzbastılar, F. O., Tanrıkul, T. T., & Pelister, C. (2015). Preliminary study on the use of the Vemco Positioning System to determine fish movements in artificial reef areas: A case study on *Sciaena umbra* Linnaeus, 1758. *Journal of Applied Ichthyology*, *31*, 41–47. https://doi.org/10.1111/jai.12922

Parrish, F. A., Hayman, N. T., Kelley, C., & Boland, R. C. (2015). Acoustic tagging and monitoring of cultured and wild juvenile crimson jobfish (*Pristipomoides filamentosus*) in a nursery habitat. *Fishery Bulletin*, *113*(3), 231–241. https://doi.org/10.7755/FB.113.3.1

Pauly, D., Christensen, V., Guénette, S., Pitcher, T. J., Sumaila, U. R., Walters, C. J., Watson, R., & Zeller, D. (2002). Towards sustainability in world fisheries. *Nature*, *418*(6898), 689–695. https://doi.org/10.1038/nature01017

Pendleton, L., Evans, K., & Visbeck, M. (2020). Opinion: We need a global movement to transform ocean science for a better world. *Proceedings of the National Academy of Sciences of the United States of America*, *117*(18), 9652–9655.

Peterson, C. H. (2003). Long-term ecosystem response to the Exxon Valdez oil spill. *Science*, *302*(5653), 2082–2086. https://doi.org/10.1126/science.1084282

Pine, W. E., Pollock, K. H., Hightower, J. E., Kwak, T. J., & Rice, J. A. (2003). A review of tagging methods for estimating fish population size and components of mortality. *Fisheries*, *28*(10), 10–23. https://doi.org/10.1577/1548-8446(2003)28[10:AROTMF]2.0.CO;2

Pioch, S., Raynal, J.-C., Lasserre, G., & Aliaume, C. (2011). An integrated coastal area management strategy to deploy artificial reefs. In S. A. Bortone, F. P. Brandini, G. Fabi, & S. Otake (Eds.), *Artificial reefs in fisheries management* (pp. 65–75). CRC Press. https://doi.org/10.1201/b10910-6

Piraino, M. N., & Szedlmayer, S. T. (2014). Fine-scale movements and home ranges of red snapper around artificial reefs in the Northern Gulf of Mexico. *Transactions of the American Fisheries Society*, *143*(4), 988–998. https://doi.org/10.1080/00028487.2014.901249

Pitcher, T. J., Watson, R., Forrest, R., Valtysson, H. P., & Guenette, S. (2002). Estimating illegal and unreported catches from marine ecosystems: A basis for change. *Fish and Fisheries*, *3*(4), 317–339. https://doi.org/10.1046/j.1467-2979.2002.00093.x

Pollara, A., Sutin, A., & Salloum, H. (2017). Passive acoustic methods of small boat detection, tracking and classification. *2017 IEEE International Symposium on Technologies for Homeland Security (HST)*, 1–6. https://doi.org/10.1109/THS.2017.7943488

Pollock, K. H., Jiang, H., & Hightower, J. E. (2004). Combining telemetry and fisheries tagging models to estimate fishing and natural mortality rates. *Transactions of the American Fisheries Society*, *133*(3), 639–648. https://doi.org/10.1577/T03-029.1

Poloczanska, E. S., Brown, C. J., Sydeman, W. J., Kiessling, W., Schoeman, D. S., Moore, P. J., Brander, K., Bruno, J. F., Buckley, L. B., Burrows, M. T., Duarte, C. M., Halpern, B. S., Holding, J., Kappel, C. V., O'Connor, M. I., Pandolfi, J. M., Parmesan, C., Schwing, F., Thompson, S. A., & Richardson, A. J. (2013). Global imprint of climate change on marine life. *Nature Climate Change*, *3*(10), 919–925. https://doi.org/10.1038/nclimate1958

Pörtner, H. O., & Knust, R. (2007). Climate change affects marine fishes through the oxygen limitation of thermal tolerance. *Science*, *315*(5808), 95–97. https://doi.org/10.1126/science.1135471

Pursche, A. R., Suthers, I. M., & Taylor, M. D. (2014). The effect of targeted stocking on behaviour and space utilization of a released finfish. *ICES Journal of Marine Science*, *71*(5), 1100–1106. https://doi.org/10.1093/icesjms/fst209

Pyle, G., & Ford, A. T. (2017). Behaviour revised: Contaminant effects on aquatic animal behaviour. *Aquatic Toxicology*, *182*, 226–228. https://doi.org/10.1016/j.aquatox.2016.11.008

Rankin, P. S., Hannah, R. W., & Blume, M. T. O. (2013). Effect of hypoxia on rockfish movements: Implications for understanding the roles of temperature, toxins and site fidelity. *Marine Ecology Progress Series*, *492*, 223–234. https://doi.org/10.3354/meps10479

Reid, A. J., Eckert, L. E., Lane, J., Young, N., Hinch, S. G., Darimont, C. T., Cooke, S. J., Ban, N. C., & Marshall, A. (2021). "Two-Eyed Seeing": An Indigenous framework to transform fisheries research and management. *Fish and Fisheries*, *22*(2), 243–261. https://doi.org/10.1111/faf.12516

Reubens, J., Verhelst, P., van der Knaap, I., Wydooghe, B., Milotic, T., Deneudt, K., Hernandez, F., & Pauwels, I. (2019). The need for aquatic tracking networks: The Permanent Belgian Acoustic Receiver Network. *Animal Biotelemetry*, *7*(1), 2. https://doi.org/10.1186/s40317-019-0164-8

Reubens, J. T., De Rijcke, M., Degraer, S., & Vincx, M. (2014). Diel variation in feeding and movement patterns of juvenile Atlantic cod at offshore wind farms. *Journal of Sea Research*, *85*, 214–221. https://doi.org/10.1016/j.seares.2013.05.005

Reubens, J. T., Pasotti, F., Degraer, S., & Vincx, M. (2013). Residency, site fidelity and habitat use of Atlantic cod (*Gadus morhua*) at an offshore wind farm using acoustic telemetry. *Marine Environmental Research*, *90*, 128–135. https://doi.org/10.1016/j.marenvres.2013.07.001

Reynolds, B. F., Powers, S. P., & Bishop, M. A. (2010). Application of acoustic telemetry to assess residency and movements of rockfish and lingcod at created and natural habitats in Prince William Sound. *PLoS ONE*, *5*(8), e12130. https://doi.org/10.1371/journal.pone.0012130

Rider, M. J., Kirsebom, O. S., Gallagher, A. J., Staaterman, E., Ault, J. S., Sasso, C. R., Jackson, T., Browder, J. A., & Hammerschlag, N. (2021). Space use patterns of sharks in relation to boat activity in an urbanized coastal waterway. *Marine Environmental Research*, *172*, 105489. https://doi.org/10.1016/j.marenvres.2021.105489

Roberts, C. M., Hawkins, J. P., & Gell, F. R. (2005). The role of marine reserves in achieving sustainable fisheries. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *360*(1453), 123–132. https://doi.org/10.1098/rstb.2004.1578

Roberts, C. M., O'Leary, B. C., McCauley, D. J., Cury, P. M., Duarte, C. M., Lubchenco, J., Pauly, D., Sáenz-Arroyo, A., Sumaila, U. R., Wilson, R. W., Worm, B., & Castilla, J. C. (2017). Marine reserves can mitigate and promote adaptation to climate change. *Proceedings of the National Academy of Sciences of the United States of America*, *114*(24), 6167–6175. https://doi.org/10.1073/pnas.1701262114

Rolland, R. M., Parks, S. E., Hunt, K. E., Castellote, M., Corkeron, P. J., Nowacek, D. P., Wasser, S. K., & Kraus, S. D. (2012). Evidence that ship noise increases stress in right whales. *Proceedings of the Royal Society B: Biological Sciences*, *279*(1737), 2363–2368. https://doi.org/10.1098/rspb.2011.2429

Ryabinin, V., Barbière, J., Haugan, P., Kullenberg, G., Smith, N., McLean, C., Troisi, A., Fischer, A., Aricò, S., Aarup, T., Pissierssens, P., Visbeck, M., Enevoldsen, H. O., & Rigaud, J. (2019). The UN decade of ocean science for sustainable development. *Frontiers in Marine Science*, *6*, 470. https://doi.org/10.3389/fmars.2019.00470

Salloum, H., Sutin, A., & Pollara, A. (2018). Detecting illegal fishing activity with acoustic technology: Passive acoustic methods help USCG fight illegal fishing. *Coast Guard Journal of Safety & Security at Sea, Proceedings of the Marine Safety & Security Council*, *75*(1), 40–44.

Salmon, M., Tolbert, M. G., Painter, D. P., Goff, M., & Reiners, R. (1995). Behavior of loggerhead sea turtles on an urban beach. II. Hatchling orientation. *Journal of Herpetology*, *29*(4), 568. https://doi.org/10.2307/1564740

Sanchez, W., Sremski, W., Piccini, B., Palluel, O., Maillot-Maréchal, E., Betoulle, S., Jaffal, A., Aït-Aïssa, S., Brion, F., Thybaud, E., Hinfray, N., & Porcher, J.-M. (2011). Adverse effects in wild fish living downstream from pharmaceutical manufacture discharges. *Environment International*, *37*(8), 1342–1348. https://doi.org/10.1016/j.envint.2011.06.002

Santos-Domínguez, D., Torres-Guijarro, S., Cardenal-López, A., & Pena-Gimenez, A. (2016). ShipsEar: An underwater vessel noise database. *Applied Acoustics*, *113*, 64–69. https://doi.org/10.1016/j.apacoust.2016.06.008

Scheffel, T. K., Hightower, J. E., Buckel, J. A., Krause, J. R., & Scharf, F. S. (2020). Coupling acoustic tracking with conventional tag returns to estimate mortality for a coastal flatfish with high rates of emigration. *Canadian Journal of Fisheries and Aquatic Sciences*, *77*(1), 1–22. https://doi.org/10.1139/cjfas-2018-0174

Schmiing, M., Afonso, P., Tempera, F., & Santos, R. (2009). Integrating recent and future marine technology in the design of Marine Protected Areas—The Azores as case study. *OCEANS 2009-EUROPE*, 1–7. https://doi.org/10.1109/OCEANSE.2009.5278178

Schofield, G., Scott, R., Dimadi, A., Fossette, S., Katselidis, K. A., Koutsoubas, D., Lilley, M. K. S., Pantis, J. D., Karagouni, A. D., & Hays, G. C. (2013). Evidence-based marine protected area planning for a highly mobile endangered marine vertebrate. *Biological Conservation*, *161*, 101–109. https://doi.org/10.1016/j.biocon.2013.03.004

Sequeira, A. M., Rodríguez, J. P., Eguíluz, V. M., Harcourt, R., Hindell, M., Sims, D. W., Duarte, C. M., Costa, D. P., Fernández-Gracia, J., Ferreira, L. C., Hays, G. C., Heupel, M. R., Meekan, M. G., Aven, A., Bailleul, F., Baylis, A. M. M., Berumen, M. L., Braun, C. D., Burns, J., … Thums, M. (2018). Convergence of marine megafauna movement patterns in coastal and open oceans. *Proceedings of the National Academy of Sciences of the United States of America*, *115*, 3072–3077.

Sertlek, H. Ö., Slabbekoorn, H., ten Cate, C., & Ainslie, M. A. (2019). Source specific sound mapping: Spatial, temporal and spectral distribution of sound in the Dutch North Sea. *Environmental Pollution*, *247*, 1143–1157. https://doi.org/10.1016/j.envpol.2019.01.119

Shillinger, G. L., Bailey, H., Bograd, S. J., Hazen, E. L., Hamann, M., Gaspar, P., Godley, B. J., Wilson, R. P., & Spotila, J. R. (2012). Tagging through the stages: Technical and ecological challenges in observing life histories through biologging. *Marine Ecology Progress Series*, *457*, 165–170. https://doi.org/10.3354/meps09816

Simard, P., Wall, K. R., Mann, D. A., Wall, C. C., & Stallings, C. D. (2016). Quantification of boat visitation rates at artificial and natural reefs in the Eastern Gulf of Mexico using acoustic recorders. *PLoS ONE*, *11*(8), e0160695. https://doi.org/10.1371/journal.pone.0160695

Simpson, S. D., Munday, P. L., Wittenrich, M. L., Manassa, R., Dixson, D. L., Gagliano, M., & Yan, H. Y. (2011). Ocean acidification erodes crucial auditory behaviour in a marine fish. *Biology Letters*, *7*(6), 917–920. https://doi.org/10.1098/rsbl.2011.0293

Simpson, S. D., Radford, A. N., Nedelec, S. L., Ferrari, M. C. O., Chivers, D. P., McCormick, M. I., & Meekan, M. G. (2016). Anthropogenic noise increases fish mortality by predation. *Nature Communications*, *7*(1), 10544. https://doi.org/10.1038/ncomms10544

Sims, D. W., Wearmouth, V. J., Southall, E. J., Hill, J. M., Moore, P., Rawlinson, K., Hutchinson, N., Budd, G. C., Righton, D., Metcalfe, J. D., Nash, J. P., & Morritt, D. (2006). Hunt warm, rest cool: Bioenergetic strategy underlying diel vertical migration of a benthic shark. *Journal of Animal Ecology*, *75*, 176–190. https://doi.org/10.1111/j.1365-2656.2005.01033.x

Slabbekoorn, H., Dalen, J., Haan, D., Winter, H. V., Radford, C., Ainslie, M. A., Heaney, K. D., Kooten, T., Thomas, L., & Harwood, J. (2019). Population-level consequences of seismic surveys on fishes: An interdisciplinary challenge. *Fish and Fisheries*, *20*(4), 653–685. https://doi.org/10.1111/faf.12367

Smith, I., Collins, K., & Jensen, A. (1999). Seasonal changes in the level and diel pattern of activity in the European lobster *Homarus gammarus*. *Marine Ecology Progress Series*, *186*, 255–264. https://doi.org/10.3354/meps186255

St John, M. A., Borja, A., Chust, G., Heath, M., Grigorov, I., Mariani, P., Martin, A. P., & Santos, R. S. (2016). A dark hole in our understanding of marine ecosystems and their services: Perspectives from the mesopelagic community. *Frontiers in Marine Science*, *3*, 31.

Staines, G., Deng, Z., Li, X., Martinez, J., Kohn, N., & Harker-Klimes, G. (2019). Using acoustic telemetry for high-resolution sablefish movement informing potential interactions with a tidal turbine.

OCEANS 2019 MTS/IEEE SEATTLE, 1–5. https://doi.org/10.23919/OCEANS40490.2019.8962600

Starr, R. M., Heine, J. N., Felton, J. M., & Cailliet, G. M. (2002). Movements of bocaccio (*Sebastes paucispinis*) and greenspotted (*S. chlorostictus*) rockfishes in a Monterey submarine canyon: Implications for the design of marine reserves. *Fisheries Bulletin*, *100*, 324–337.

Stolkin, R., Sutin, A., Radhakrishnan, S., Bruno, M., Fullerton, B., Ekimov, A., & Raftery, M. (2006). Feature based passive acoustic detection of underwater threats. In M. J. DeWeert, T. T. Saito, & H. L. Guthmuller (Eds.), *Proceedings of SPIE*. https://doi.org/10.1117/12.663651

Sumaila, U. R., Dyck, A., & Cheung, W. W. L. (2013). Fisheries subsidies and potential catch loss in SIDS Exclusive Economic Zones: Food security implications. *Environment and Development Economics*, *18*(4), 427–439. https://doi.org/10.1017/S1355770X13000156

Sumaila, U. R., Alder, J., & Keith, H. (2006). Global scope and economics of illegal fishing. *Marine Policy*, *30*(6), 696–703. https://doi.org/10.1016/j.marpol.2005.11.001

Taylor, M. D., Becker, A., & Lowry, M. B. (2018). Investigating the functional role of an artificial reef within an estuarine seascape: A case study of yellowfin bream (*Acanthopagrus australis*). *Estuaries and Coasts*, *41*(6), 1782–1792. https://doi.org/10.1007/s12237-018-0395-6

Taylor, M. D., Chick, R. C., Lorenzen, K., Agnalt, A.-L., Leber, K. M., Blankenship, H. L., Haegen, G. V., & Loneragan, N. R. (2017). Fisheries enhancement and restoration in a changing world. *Fisheries Research*, *186*, 407–412. https://doi.org/10.1016/j.fishres.2016.10.004

Taylor, M. D., Fairfax, A. V., & Suthers, I. M. (2013). The race for space: Using acoustic telemetry to understand density-dependent emigration and habitat selection in a released predatory fish. *Reviews in Fisheries Science*, *21*(3–4), 276–285. https://doi.org/10.1080/10641262.2013.796813

Taylor, M. D., van der Meulen, D. E., Brodie, S., Cadiou, G., & Knott, N. A. (2018). Applying acoustic telemetry to understand contaminant exposure and bioaccumulation patterns in mobile fishes. *Science of the Total Environment*, *625*, 344–354. https://doi.org/10.1016/j.scitotenv.2017.12.177

Thorstad, E. B., Uglem, I., Finstad, B., Kroglund, F., Einarsdottir, I. E., Kristensen, T., Diserud, O., Arechavala-Lopez, P., Mayer, I., Moore, A., Nilsen, R., Björnsson, B. T., & Økland, F. (2013). Reduced marine survival of hatchery-reared Atlantic salmon post-smolts exposed to aluminium and moderate acidification in freshwater. *Estuarine, Coastal and Shelf Science*, *124*, 34–43. https://doi.org/10.1016/j.ecss.2013.03.021

Thums, M., Whiting, S. D., Reisser, J., Pendoley, K. L., Pattiaratchi, C. B., Proietti, M., Hetzel, Y., Fisher, R., & Meekan, M. G. (2016). Artificial light on water attracts turtle hatchlings during their near shore transit. *Royal Society Open Science*, *3*(5), 160142. https://doi.org/10.1098/rsos.160142

Tickler, D. M., Carlisle, A. B., Chapple, T. K., Curnick, D. J., Dale, J. J., Schallert, R. J., & Block, B. A. (2019). Potential detection of illegal fishing by passive acoustic telemetry. *Animal Biotelemetry*, *7*, 1. https://doi.org/10.1186/s40317-019-0163-9

TinHan, T. C., Mohan, J. A., Dumesnil, M., DeAngelis, B. M., & Wells, R. J. D. (2018). Linking habitat use and trophic ecology of spotted seatrout (*Cynoscion nebulosus*) on a restored oyster reef in a subtropical estuary. *Estuaries and Coasts*, *41*(6), 1793–1805. https://doi.org/10.1007/s12237-018-0391-x

Topping, D. T., & Szedlmayer, S. T. (2011). Home range and movement patterns of red snapper (*Lutjanus campechanus*) on artificial reefs. *Fisheries Research*, *112*(1–2), 77–84. https://doi.org/10.1016/J.FISHRES.2011.08.013

Topping, D. T., & Szedlmayer, S. T. (2013). Use of ultrasonic telemetry to estimate natural and fishing mortality of red snapper. *Transactions of the American Fisheries Society*, *142*(4), 1090–1100. https://doi.org/10.1080/00028487.2013.790844

UN. (2015). *Transforming our world: The 2030 agenda for sustainable development* (p. 35).

UNEP-WCMC and IUCN. (2021). *Protected Planet: The World Database on Protected Areas (WDPA)*. UNEP-WCMC and IUCN.

Urke, H. A., Kristensen, T., Ulvund, J. B., & Alfredsen, J. A. (2013). Riverine and fjord migration of wild and hatchery-reared Atlantic salmon smolts. *Fisheries Management and Ecology*, *20*(6), 544–552. https://doi.org/10.1111/fme.12042

van der Knaap, I., Reubens, J., Thomas, L., Ainslie, M. A., Winter, H. V., Hubert, J., Martin, B., & Slabbekoorn, H. (2021). Effects of a seismic survey on movement of free-ranging Atlantic cod. *Current Biology*, *31*(7), 1555–1562. https://doi.org/10.1016/j.cub.2021.01.050

van der Knaap, I., Slabbekoorn, H., Moens, T., Van den Eynde, D., & Reubens, J. (2022). Effects of pile driving sound on local movement of free-ranging Atlantic cod in the Belgian North Sea. *Environmental Pollution*, *300*, 118913. https://doi.org/10.1016/j.envpol.2022.118913

Vander Zanden, H. B., Bolten, A. B., Tucker, A. D., Hart, K. M., Lamont, M. M., Fujisaki, I., Reich, K. J., Addison, D. S., Mansfield, K. L., Phillips, K. F., Pajuelo, M., & Bjorndal, K. A. (2016). Biomarkers reveal sea turtles remained in oiled areas following the Deepwater Horizon oil spill. *Ecological Applications*, *26*(7), 2145–2155. https://doi.org/10.1002/eap.1366

Villegas-Ríos, D., Claudet, J., Freitas, C., Moland, E., Thorbjørnsen, S. H., Alonso-Fernández, A., & Olsen, E. M. (2021). Time at risk: Individual spatial behaviour drives effectiveness of marine protected areas and fitness. *Biological Conservation*, *263*, 109333. https://doi.org/10.1016/j.biocon.2021.109333

Villegas-Ríos, D., Freitas, C., Moland, E., Thorbjørnsen, S. H., & Olsen, E. M. (2020). Inferring individual fate from aquatic acoustic telemetry data. *Methods in Ecology and Evolution*, *11*(10), 1186–1198. https://doi.org/10.1111/2041-210X.13446

Walters, C. J., & Martell, S. J. D. (2005). *Fisheries ecology and management*. Princeton University Press. https://doi.org/10.1515/9780691214634

Wardle, C. S., Carter, T. J., Urquhart, G. G., Johnstone, A. D. F., Ziolkowski, A. M., Hampson, G., & Mackie, D. (2001). Effects of seismic air guns on marine fish. *Continental Shelf Research*, *21*(8–10), 1005–1027. https://doi.org/10.1016/S0278-4343(00)00122-9

Watson, J. T., & Haynie, A. C. (2016). Using vessel monitoring system data to identify and characterize trips made by fishing vessels in the United States North Pacific. *PLoS ONE*, *11*(10), e0165173. https://doi.org/10.1371/journal.pone.0165173

Wenger, A. S., Harvey, E., Wilson, S., Rawson, C., Newman, S. J., Clarke, D., Saunders, B. J., Browne, N., Travers, M. J., Mcilwain, J. L., Erftemeijer, P. L. A., Hobbs, J.-P. A., Mclean, D., Depczynski, M., & Evans, R. D. (2017). A critical analysis of the direct effects of dredging on fish. *Fish and Fisheries*, *18*(5), 967–985. https://doi.org/10.1111/faf.12218

Wilson, P., Thums, M., Pattiaratchi, C., Meekan, M., Pendoley, K., Fisher, R., & Whiting, S. (2018). Artificial light disrupts the nearshore dispersal of neonate flatback turtles *Natator depressus*. *Marine Ecology Progress Series*, *600*, 179–192. https://doi.org/10.3354/meps12649

Winter, H. V., Aarts, G., & van Keeken, O. A. (2010). *Residence time and behaviour of sole and cod in the Offshore Wind farm Egmond aan Zee (OWEZ)*.

Young, J. M., Bowers, M. E., Reyier, E. A., Morley, D., Ault, E. R., Pye, J. D., Gallagher, R. M., & Ellis, R. D. (2020). The FACT network: Philosophy, evolution, and management of a collaborative coastal tracking network. *Marine and Coastal Fisheries*, *12*(5), 258–271. https://doi.org/10.1002/mcf2.10100

Zięba, G., Stakenas, S., Ives, M., Godard, M. J., Seymour, J., Carter, M. G., & Copp, G. H. (2014). Long-term decline of barbel *Barbus barbus* in the original course of the Lower River Lee (England), with particular reference to the survival of tagged fish during a water pollution incident. *Fundamental and Applied Limnology*, *185*(1), 43–53. https://doi.org/10.1127/fal/2014/0542

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