

In this review:

A. Recent articles with abstracts

O/A denotes an open access article or journal

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Guy, C. and Roberts, D. Can the spread of non-native oysters (*Crassostrea gigas*) at the early stages of population expansion be managed? *Marine Pollution Bulletin* 60(7): 1059-1064, 2010.

Notes: The Pacific oyster (*Crassostrea gigas*) was introduced into Strangford Lough, Northern Ireland in the 1970s. It was assumed that local environmental conditions would not facilitate successful reproduction. However, in the 1990s there were reports of *C. gigas* outside licensed aquaculture sites and this investigation set out to ascertain the current distribution, years of likely recruitment and population structure of the species. *C. gigas* were found distributed widely throughout the northern basin during surveys; the frequency distribution suggesting *C. gigas* is not recruiting every year. Establishment of feral populations of *C. gigas* elsewhere have linked to habitat change. A pilot cull was initiated to assess the success rate of early intervention. This paper demonstrates the potential benefits of responding rapidly to initial reports of non-native species in a way that may curtail establishment and expansion. The method advocated is simple and can be recommended to the appropriate regulatory authorities.

Haupt, T.M., Griffiths, C.L., Robinson, T.B., and Tonin, A.F.G. Oysters as vectors of marine aliens, with notes on four introduced species associated with oyster farming in South Africa. *African Zoology* 45(1): 52-62, 2010.

Notes: Translocated oysters are well known to act as vectors of marine alien species, but to date this topic has received scant attention in South Africa, despite the fact that oysters have been imported into this region since 1894. Surveys of oyster farms in South Africa revealed four newly-recorded alien species: the black sea urchin, *Tetrapygus niger*, from Chile; the European flat oyster, *Ostrea edulis* (thought to be extinct since its intentional introduction in 1946); Montagu's crab, *Xantho incisus*, from the North Eastern Atlantic seas of Europe, and the brachiopod *Discinisa tenuis* from Namibia. Oyster imports are the most likely vector of all these species. The biological attributes of each species, the possible threats posed by their introduction, and the needs for additional control measures to limit or prevent further introduction and spread of alien species via oyster culture are discussed.

Loebmann, D., Mai, A.C.G., and Lee, J.T. The invasion of five alien species in the Delta do Parnaíba Environmental Protection Area, Northeastern Brazil. *Revista de Biologia Tropical* 58(3): 909-923, 2010. O/A

Notes: Marine biological invasions have been regarded as one of the major causes of native biodiversity loss, with shipping and aquaculture being the leading contributors for the introductions of alien species in aquatic ecosystems. In the present study, five aquatic alien species (one mollusk, three crustaceans and one fish species) were detected during dives, shore searches and from the fisheries on the coast of the Delta do Parnaíba Environmental Protection Area, in the States of Piauí and Maranhão, Northeastern Brazil. The species were the bicolor purse-oyster *Isognomon bicolor*, the whiteleg shrimp *Litopenaeus*

vannamei, the giant river prawn *Macrobrachium rosenbergii*, the Indo-Pacific swimming crab *Charybdis hellerii* and, the muzzled blenny *Omobranchus punctatus*. Ballast water (*I. bicolor*, *C. hellerii*, and *O. punctatus*) and aquaculture activities (*L. vannamei* and *M. rosenbergii*) in adjacent areas are the most likely vectors of introduction. All exotic species found have potential impact risks to the environment because they are able to compete against native species for resources (food and habitat). *Isognomon bicolor* share the same habitat and food items with the native bivalve species of mussels and barnacles. *Litopenaeus vannamei* share the same habitat and food items with the native penaeids such as the pinkspot shrimp *Farfantepenaeus brasiliensis*, the Southern brown shrimp *Farfantepenaeus subtilis*, and the Southern white shrimp *Litopenaeus schmitti*, and in the past few years *L. vannamei* was responsible for a viral epidemics in the cultivation tanks that could be transmitted to native penaeid shrimps. *Charybdis hellerii* is also able to cause impacts on the local fisheries as the species can decrease the populations of native portunid crabs which are commercialized in the studied region. *Macrobrachium rosenbergii* may be sharing natural resources with the Amazon River prawn *Macrobrachium amazonicum*. *Omobranchus punctatus* shares habit with the native redlip blenny *Ophioblennius atlanticus* and other fishes, such as the frillfin goby *Bathigobius soporator*. Some immediate remedial measures to prevent further introductions from ballast water and shrimp farm ponds should be: (i) to prevent the release of ballast water by ship/vessels in the region; (ii) to reroute all effluent waters from shrimp rearing facilities through an underground or above-ground dry well; (iii) to install adequate sand and gravel filter which will allow passage of water but not livestock; (iv) outdoor shrimp ponds located on floodable land should be diked, and; (v) to promote environmental awareness of those directly involved with ballast water (crews of ship/vessels) and shrimp farms in the region.

Katsanevakis, S., Poursanidis, D., Issaris, Y., Tsiamis, K., Salomidi, M., Maroulakis, M., Kytinou, E., Thessalou-Legaki, M., and Zenetos, A. The invasive crab *Percnon gibbesi* (Crustacea: Decapoda: Plagusidiidae) is spreading in the Aegean and Ionian Seas. *Marine Biodiversity Records* 3: art. e53, 2010.

Notes: *Percnon gibbesi* is an opportunistic feeder, feeding primarily on algae, of the shallow infra-littoral rocky shores. It was first observed in 1999 in the Mediterranean Sea and has rapidly spread since then. The range expansion of the species in the Aegean and Ionian Seas was recorded and evidence of its further establishment in Greek waters was provided. Established populations were observed in areas where it had not been previously reported: the Saronikos Gulf (central Aegean Sea), Chios Island (central Aegean Sea), Milos Island (central Aegean Sea), Zakynthos Island (central Ionian Sea) and Syvota (north-eastern coast of the Ionian Sea). The species was also observed in new sites in the Messiniakos Gulf, Crete and Rhodes Island, where it had been previously reported. The species keeps spreading in the Mediterranean Sea with a high rate of expansion.

Deem, S.L., Merkel, J., Ballweber, L., Vargas, F.H., Cruz, M.B., and Parker, P.G. Exposure to *Toxoplasma gondii* in Galapagos penguins (*Spheniscus mendiculus*) and flightless cormorants (*Phalacrocorax harrisi*) in the Galapagos Islands, Ecuador. *Journal of Wildlife Diseases* 46(3): 1005-1011, 2010.

Notes: *Toxoplasma gondii* is one of the most common protozoan parasites of humans and warm-blooded animals. Members of the family Felidae are the only definitive hosts of this parasite and, thus, important in the epidemiology of the disease. Previous studies on Pacific islands have found *T. gondii* infections in a number of avian species where domestic cats (*Felis catus*) have been introduced. Little is known about *T. gondii* in the Galapagos Islands, although introduced domestic cats in the archipelago are known to be *T. gondii* antibody-positive. In this study, we quantified prevalence of antibody to *T. gondii* in two threatened avian marine species, Galapagos penguins (*Spheniscus mendiculus*) and flightless cormorants (*Phalacrocorax harrisi*), and tested the hypothesis that this parasite is more prevalent on Isabela Island (with cats) than on Fernandina Island (without cats). Overall, antibody prevalence was 2.3% in both Galapagos penguins and flightless cormorants from samples collected during 2003-2005, and in 2008. In Galapagos penguins (n = 298), a significantly higher antibody prevalence was found in penguins on Fernandina Island (free of cats) than on Isabela Island (with cats, Fisher's exact test, P = 0.02). In flightless cormorants (n = 258), there was a higher antibody prevalence in cormorants living on Isabela than on Fernandina, although this difference was not statistically significant (Fisher's, P = 0.19). This study is the first to show exposure to *T. gondii* in endemic avian species in the Galapagos Islands, providing evidence for disease-related risks associated with the feral cat population in the archipelago. We provide possible explanations for these findings and recommendations for future studies towards a better understanding of the epidemiology of *T. gondii* in the Galapagos Islands.

Almqvist, G., Strandmark, A.K., and Appelberg, M. Has the invasive round goby caused new links in Baltic food webs? *Environmental Biology of Fishes* 89(1): 79-93, 2010. O/A

Notes: The Ponto-Caspian round goby (*Neogobius melanostomus*, Pallas 1814) most probably was established in the Gulf of Gdansk, Baltic Sea, in the late 1980's and has since become one of the dominant species in the region. In this study we assess the role of round gobies as prey for two important fish species in the Gulf of Gdansk, cod (*Gadus morhua*) and perch (*Perca fluviatilis*). We compared their present diet with stomach analyses from the area prior the round goby establishment, as well as with diet analysis from Baltic regions where round gobies are absent. There were large differences in the diet between cods from the Gulf of Gdansk 2003-2006 compared to cods in earlier studies (1977-1981) from the Southern Baltic Sea. There were also large differences in cod and perch diets from areas with and without round goby. Presently, round goby constitutes the most important prey for medium sized cods in Gulf of Gdansk, and perch from the same area almost exclusively feed on gobiids. Stomach analysis, trophic level estimates, and stable isotope analyses all indicated that cod and perch in Gulf of Gdansk after the round goby establishment belonged to a similar trophic level. Beside round goby, no mussel feeding fish contributed much to the diet of cod or at all to the diet of perch. Thus, it is likely that round gobies constitute a new energetic pathway from mussels to top predators. However, due to the short time elapsed after round goby establishment, we can only speculate on the species future impacts on Baltic food webs.

Van Houtan, K.S., Hargrove, S.K., and Balazs, G.H. Land use, macroalgae, and a tumor-forming disease in marine turtles. *PLoS ONE* 5(9): art. e12900, 2010. O/A

Notes: Wildlife diseases are an increasing concern for endangered species conservation, but their occurrence, causes, and human influences are often unknown. We analyzed 3,939 records of stranded Hawaiian green sea turtles (*Chelonia mydas*) over 28 years to understand fibropapillomatosis, a tumor-forming disease linked to a herpesvirus. Turtle size is a consistent risk factor and size-standardized models revealed considerable spatial and temporal variability. The disease peaked in some areas in the 1990s, in some regions rates remained constant, and elsewhere rates increased. Land use, onshore of where the turtles feed, may play a role. Elevated disease rates were clustered in watersheds with high nitrogen-footprints; an index of natural and anthropogenic factors that affect coastal eutrophication. Further analysis shows strong epidemiological links between disease rates, nitrogen-footprints, and invasive macroalgae and points to foraging ecology. These turtles now forage on invasive macroalgae, which can dominate nutrient rich waters and sequester environmental N in the amino acid arginine. Arginine is known to regulate immune activity, promote herpesviruses, and contribute to tumor formation. Our results have implications for understanding diseases in aquatic organisms, eutrophication, herpesviruses, and tumor formation.

Katsanevakis, S., Salomidi, M., and Panou, A. Modelling distribution patterns and habitat preference of the invasive green alga *Caulerpa racemosa* in the Saronikos Gulf (Eastern Mediterranean). *Aquatic Biology* 10(1): 57-67, 2010.

Notes: Although the invasive alga *Caulerpa racemosa* has exhibited an excessive rate of proliferation and has invaded the entire Mediterranean Sea basin within the last 18 yr, its spatial distribution patterns remain largely unknown. A 2-component modelling approach based on generalized additive models was applied to model the density of *C. racemosa* fronds in relation to spatial and environmental variables. A bimodal distribution of presence probability in relation to depth was observed, with higher probabilities of occurrence at very shallow bottoms (<4 m) and at depths between ~15 and 30 m. Presence probability steadily decreased at greater depths. Frond density was markedly higher in rocky habitats than in *Posidonia oceanica* beds or on sandy/muddy bottoms. The highest frond densities were observed in the southeastern part of the Saronikos Gulf, which is considered to be the area of initial establishment of the species in the Gulf; this indicates that time favours the steady expansion and further dominance of this species.

Sweetman, A.K., Middelburg, J.J., Berle, A.M., Bernardino, A.F., Schander, C., Demopoulos, A.W.J., and Smith, C.R. Impacts of exotic mangrove forests and mangrove deforestation on carbon remineralization and ecosystem functioning in marine sediments. *Biogeochemistry* 7(7): 2129-2145, 2010. O/A

Notes: To evaluate how mangrove invasion and removal can modify short-term benthic carbon cycling and ecosystem functioning, we used stable-isotopically labeled algae as a deliberate tracer to quantify benthic respiration and C-flow over 48 h through macrofauna and bacteria in sediments collected from (1) an invasive mangrove forest, (2) deforested mangrove sites 2 and 6 years after removal of above-sediment mangrove biomass, and (3) two mangrove-free control sites in the Hawaiian coastal zone. Sediment oxygen consumption (SOC) rates averaged over each 48 h investigation were significantly greater in the mangrove and mangrove removal site experiments than in controls and were significantly correlated with total benthic (macrofauna and bacteria) biomass and sedimentary mangrove biomass (SMB). Bacteria dominated short-term C-processing of added microalgal-C and benthic biomass in sediments from the invasive mangrove forest habitat and in the 6-yr removal site. In contrast, macrofauna were the most important agents in the short-term processing of microalgal-C in sediments from the 2-yr mangrove removal site and control sites. However, mean faunal abundance and C-uptake rates in sediments from both removal sites were significantly higher than in control cores, which collectively suggest that community structure and short-term C-cycling dynamics of sediments in habitats where mangroves have been cleared can remain fundamentally different from un-invaded mudflat sediments for at least 6-yrs following above-sediment mangrove removal. In summary, invasion by mangroves can lead to dramatic shifts in benthic ecosystem function, with sediment metabolism, benthic community structure and short-term C-remineralization dynamics being affected for years following invader removal.

Troost, K. Causes and effects of a highly successful marine invasion: Case-study of the introduced Pacific oyster *Crassostrea gigas* in continental NW European estuaries. *Journal of Sea Research* 64(3): 145-165, 2010.

Notes: Since the 1960's, the Pacific oyster *Crassostrea gigas* has been introduced for mariculture at several locations within NW Europe. The oyster established itself everywhere and expanded rapidly throughout the receiving ecosystems, forming extensive and dense reef structures. It became clear that the Pacific oyster induced major changes in NW European estuaries. This paper reviews the causes of the Pacific oyster's remarkably successful establishment and spread in The Netherlands and neighbouring countries, and includes a comprehensive review of consequences for the receiving communities. Ecosystem engineering by *C. gigas* and a relative lack of natural enemies in receiving ecosystems are identified as the most important characteristics facilitating the invader's successful establishment and expansion. The Pacific oyster's large filtration capacity and eco-engineering characteristics induced many changes in receiving ecosystems. Different estuaries are affected differently; in the Dutch Oosterschelde estuary expanding stocks saturate the carrying capacity whereas in the Wadden Sea no such problems exist. In general, the Pacific oyster seems to fit well within continental NW European estuarine ecosystems and there is no evidence that the invader outcompetes native bivalves. *C. gigas* induces changes in plankton composition, habitat heterogeneity and biodiversity, carrying capacity, food webs and parasite life cycles. The case of the Pacific oyster in NW European estuaries is only one example in an increasing series of biological invasions mediated by human activities. This case-study will contribute to further elucidating general mechanisms in marine invasions; invasions that sometimes appear a threat, but can also contribute to ecological complexity.

Tsai, C.C., Yang, S., Trimble, A.C., and Ruesink, J.L. Interactions between two introduced species: *Zostera japonica* (dwarf eelgrass) facilitates itself and reduces condition of *Ruditapes philippinarum* (Manila clam) on intertidal flats. *Marine Biology* 157(9): 1929-1936, 2010.

Notes: Dwarf eelgrass (duckgrass; *Zostera japonica*) and Manila clams (*Ruditapes philippinarum*) are two introduced species that co-occur on intertidal flats of the northeast Pacific. Through factorial manipulation of clam (0, 62.5, 125 clams m⁻²) and eelgrass density (present, removed by hand, harrowed), we examined intra- and interspecific effects on performance, as well as modification of the physical environment. The presence of eelgrass reduced water flow by up to 40% and was also observed to retain water at low tide, which may ameliorate desiccation and explain why eelgrass grew faster in the presence of conspecifics (positive feedback). Although shell growth of small (20-50 mm) clams was not consistently affected by either treatment in this 2-month experiment, clam condition improved when eelgrass was removed. Reciprocally, clams at aquaculture densities had no effect on eelgrass growth, clam growth and condition, or porewater nutrients. Overall, only *Z. japonica* demonstrated strong population-level interactions. Interspecific results support an emerging paradigm that invasive marine ecosystem engineers

often negatively affect infauna. Positive feedbacks for *Z. japonica* may characterize its intraspecific effects particularly at the stressful intertidal elevation of this study (+1 m above mean lower low water).

Moutou, F. and Pastoret, P.P. Invasive mammals. *Revue scientifique et technique de l'Office international des Epizooties* 29(2): 209-216, 2010. O/A

Notes: Every region of the world is concerned by potential mammal invasions, as humans are already present on all the world's land masses. All these invasions are a result of species introductions by humans for one reason or another. The authors briefly review the known movements and observed consequences of mammal-related invasions. They take examples from all five continents, as well as from a few island systems. The ancient introduction of game species, and later of domestic species, has been followed more recently by movements of commercial species. We are now seeing the emergence of what are known as entertainment species. In a number of cases, such introductions have led to the establishment of new epidemiological cycles that previously might never have been thought possible. According to current indicators, this phenomenon is not on the wane.

Hoberg, E.P. Invasive processes, mosaics and the structure of helminth parasite faunas. *Revue scientifique et technique de l'Office international des Epizooties* 29(2): 255-272, 2010. O/A

Notes: The biosphere in evolutionary and ecological time has been structured by episodes of geographic and host colonisation that have determined distributions of complex assemblages of microparasites and macroparasites, including helminths circulating among vertebrates. Biological invasion is an intricate phenomenon often involving 'extra-range dispersal' and establishment of exotic (non-indigenous) species and populations substantially beyond their native range. Invasion may also involve the expansion or shifting of host and geographic distributions of an endemic (indigenous) species or fauna under changing environmental conditions. Invasions result in faunal interchange occurring under influences from both natural and anthropogenic forces where expansion on spatial/temporal continua bridges continents, regions and landscapes. Drivers for invasion are idiosyncratic, multifactorial, interactive, and opportunistic, with a powerful role for historical contingency. The life history patterns of helminths interact with invasion pathways to determine the potential for introduction. Human-mediated events, such as the global expansion of pathogens linked to development of agriculture, domestication of food animals, and European exploration have had a pervasive influence on the distribution of helminths. Globalisation, broad transport networks and environmental perturbation linked to climate change, along with other drivers, have accelerated these processes. A consequence of invasion and establishment of exotic species is that faunal structure will be a mosaic that includes admixtures of indigenous and non-indigenous species and populations; exemplified by helminth faunas among domestic and free-ranging ungulates and a diversity of host-parasite systems among vertebrates. Contemporary mosaics are evident where human-mediated events have brought assemblages of new invaders and relatively old endemic species into sympatry, highlighting interactions at ecotones, particularly those at borderlands between managed and natural ecosystems. Understanding the historical origins and complex components of mosaics is essential in formulating predictions about future responses to environmental change. Powerful tools are available which support the study of invasive species, the most important being systematics and our capacity to accurately identify parasites and to define evolutionary and biogeographic history. Faunal baselines derived from arrays of biological specimens, integrated surveys and informatics are a permanent record of the biosphere when archived in museum collections. The absence of comprehensive taxonomic inventories of parasites, including molecular-genetic data, limits our ability to recognise the introduction of non-indigenous parasites, and to document patterns of expansion for local faunas under a regime of environmental perturbation.

Pascal, M., Le Guyader, H., and Simberloff, D. Biological invasions and the conservation of biodiversity. *Revue scientifique et technique de l'Office international des Epizooties* 29(2): 387-403, 2010. O/A

Notes: Consideration of definitions of 'biological invasion' and 'biodiversity' shows why invasions have recently generated great interest among conservationists. Many studies show that invasion numbers have increased drastically over the last five centuries, that this exponential increase is not levelling off, and that human activities are the only reason for the phenomenon. Many mechanisms are portrayed in an evolutionary framework and their consequences for biodiversity are described at three

levels of life – gene, species and ecosystem. Examples from islands show that insular ecosystems are especially prone to damage from invasions; they also serve as 'laboratories' to elucidate the nature of invasion impacts. An important management approach – eradication – is discussed. Eradicating invaders not only aids understanding of their impacts on native species but also in understanding how ecosystems function. In fact, biological invasions can be seen as 'experiments', providing a rare opportunity to help answer certain fundamental scientific questions.

Shimura, J., Coates, D., and Mulongoy, J.K. The role of international organisations in controlling invasive species and preserving biodiversity. *Revue scientifique et technique de l'Office international des Epizooties* 29(2): 405-410, 2010. O/A

Notes: Invasive alien species spread through the environment and threaten native biodiversity, assisted by the absence of natural enemies. Alien species may also carry pathogens, which can be transmitted to native species. About half of the known endangered species are under threat from invasive alien species. The Conference of the Parties to the Convention on Biological Diversity in 2008 invited relevant international organisations to work together to fill the gap in the international regulatory framework on invasive alien species. The Convention also reaffirmed the need for capacity and expertise to deal with invasive alien species in many countries, especially in developing countries. In this paper, the authors review the findings of this project.

Lasso-Alcalá, O.M. and Posada, J.M. Presence of the invasive red lionfish, *Pterois volitans* (Linnaeus, 1758), on the coast of Venezuela, southeastern Caribbean Sea. *Aquatic Invasions* 5(Suppl. 1): S53-S59, 2010. O/A

Notes: We report the presence of the invasive Indo-Pacific red lionfish (*Pterois volitans*) in 23 localities of the Venezuelan coast, southeastern Caribbean Sea. This finding is based on ten specimens collected at Parque Nacional Archipiélago de Los Roques (PNAR, Dependencias Federales), Playa Cal, Caraballeda and Puerto Carayaca (Estado Vargas) and 30 specimens observed in 18 localities of PNAR, Parque Nacional Morrocoy (Estado Falcón), Bahía de Cata, Ensenada de Cepe (Estado Aragua), Puerto Cruz, Chichiriviche de La Costa, Mamo, Catia La Mar, La Guaira, Macuto, Caraballeda (Estado Vargas) and Farallón Centinela (Dependencias Federales). The specimens were collected and observed from November 2009 to June 2010. This is the first published report documenting their occurrence in Venezuela.

Ocaña-Luna, A., Sánchez-Ramírez, M., and Aguilar-Durán, R. First record of *Phyllorhiza punctata* von Lendenfeld, 1884 (Cnidaria: Scyphozoa, Mastigiidae) in Mexico. *Aquatic Invasions* 5(Suppl. 1): S79-S84, 2010. O/A

Notes: The Australian spot jellyfish *Phyllorhiza punctata* has not been recorded previously for any coast of Mexico. A giant jellyfish was recorded for the first time in June 2006 in Laguna de Mandinga, southwestern Gulf of Mexico. Between 2007 and 2008, another three adult specimens were collected and later in May 2009 and April-June 2010 a great number of juveniles and adults were observed, of which 142 were collected. The presence of juveniles and adults throughout five consecutive years indicates that the species has a seasonal pattern. It migrates from the Sistema Arrecifal Veracruzano (SAV) into Laguna de Mandinga during the spring, aided by the tide that flows along the estuary of the Jamapa River. The population then decreases at the end of the summer, during the rainy season, when salinity decreases (10 psu). The recruitment area of the polyps is probably associated with the coral reefs in the SAV.

Bouiadjra, B.B., Taleb, M.Z., Marouf, A., Benkada, M.Y., and Riadi, H. First record of the invasive alga *Caulerpa racemosa* (Caulerpales, Chlorophyta) in the Gulf of Arzew (western Algeria). *Aquatic Invasions* 5(Suppl. 1): S97-S101, 2010. O/A

Notes: The first invasive record of the green alga *Caulerpa racemosa* (Forsskal) J. Agardh in the Mediterranean Sea was in 1990 in Tripoli (Libya) (J. Agardh) and since that period, this Chlorophyta has been rapidly spreading to all Mediterranean countries.

However, very few assessment studies have been carried out along the Algerian coast. In this paper, we present, for the first time new observation data concerning an indicated proliferation of this invasive species in Salamandre and Stidia (Gulf of Arzew, western Algeria); both these sites are very important for sea fishing activities and traffic.

Garcia-de-Lomas, J., Dana, E.D., López-Santiago, J., González, R., Ceballos, G., and Ortega, F. Management of the Chinese mitten crab, *Eriocheir sinensis* (H. Milne Edwards, 1853) in the Guadalquivir Estuary (Southern Spain). *Aquatic Invasions* 5(3): 323-330, 2010. O/A

Notes: The Chinese mitten crab *Eriocheir sinensis* was first recorded in the Guadalquivir Estuary in 1987. Management actions by the Andalusian Regional Government were implemented in 2001 to contain and reduce the population of this invasive crab in the estuary and also to prevent its dispersal to neighbouring natural protected areas. Our results showed a heterogeneous distribution of the mitten crabs in the estuary, concentrated in the Sevilla port area. The catch-per-unit-effort (CPUE) in traps was significantly higher in October-April. Annual CPUE decreased from 0.04 crabs net⁻¹d⁻¹ to minimum values of 0.006 crabs net⁻¹d⁻¹ in 2008, thus reducing the dispersal potential to neighbouring areas. However, given that a number of stochastic factors may be involved in fluctuations in population size and that ships' ballast water remains uncontrolled, the management of *E. sinensis* needs to be continued. Based on the results obtained and the expected sequence of the invasion process in the Guadalquivir Estuary, we propose further management improvements. These results may help to optimize the management of this invasive species both in the Guadalquivir estuary and in comparable scenarios in different parts of the world.

Liao, Y.C., Chen, L.S., and Shao, K.T. The predatory Atlantic red drum, *Sciaenops ocellatus*, has invaded the western Taiwanese coast in the Indo-West Pacific. *Biological Invasions* 12(7): 1961-1965, 2010.

Notes: The red drums, *Sciaenops ocellatus*, are predatory marine fish from Atlantic American coast. They were introduced to Taiwan for aquaculture purpose in 1987 and have been reported in the wild along the southwest coast of Taiwan since 1998. Their current distribution is on the western coast of Taiwan and the Matsu Islands of Fujian Province where there are sand and mud bottoms. However, the discontinuous populations of Taiwan and Matsu indicated different sources of introduction. The fact that there are consecutive records of red drums for 7 years including every single month, at multiple localities, and the fish's larger size all point to their survival in the wild. The mechanisms of their introductions are probably the escapes from net cages as well as the deliberate releases to improve fisheries and for religious activities. This paper documents for the first time a marine fish has invaded and established in coastal water off western Taiwan and the Indo-West Pacific. The ecological impact of red drums on the local fish community is still unknown and calls for further studies.

Fourqurean, J.W., Smith, T.J., Possley, J., Collins, T.M., Lee, D., and Namoff, S. Are mangroves in the tropical Atlantic ripe for invasion? Exotic mangrove trees in the forests of South Florida. *Biological Invasions* 12(8): 2509-2522, 2010.

Notes: Two species of mangrove trees of Indo-Pacific origin have naturalized in tropical Atlantic mangrove forests in South Florida after they were planted and nurtured in botanic gardens. Two *Bruguiera gymnorrhiza* trees that were planted in the intertidal zone in 1940 have given rise to a population of at least 86 trees growing interspersed with native mangrove species *Rhizophora mangle*, *Avicennia germinans* and *Laguncularia racemosa* along 100 m of shoreline; the population is expanding at a rate of 5.6% year⁻¹. Molecular genetic analyses confirm very low genetic diversity, as expected from a population founded by two individuals. The maximum number of alleles at any locus was three, and we measured reduced heterozygosity compared to native-range populations. *Lumnitzera racemosa* was introduced multiple times during the 1960s and 1970s, it has spread rapidly into a forest composed of native *R. mangle*, *A. germinans*, *Laguncularia racemosa* and *Conocarpus erectus* and now occupies 60,500 m² of mangrove forest with stem densities of 24,735 ha⁻¹. We estimate the population growth rate of *Lumnitzera racemosa* to be between 17 and 23% year⁻¹. Populations of both species of naturalized mangroves are dominated by young individuals. Given the long life and water-dispersed nature of propagules of the two exotic species, it is likely that they have spread beyond our survey area. We argue that the species-depauperate nature of tropical Atlantic mangrove forests and close taxonomic relatives in the more species-rich Indo-Pacific region result in the susceptibility of tropical Atlantic mangrove forests to invasion by Indo-Pacific mangrove species.

Wanless, R.M., Scott, S., Sauer, W.H.H., Andrew, T.G., Glass, J.P., Godfrey, B., Griffiths, C., and Yeld, E. Semi-submersible rigs: a vector transporting entire marine communities around the world. *Biological Invasions* 12(8): 2573-2583, 2010.

Notes: A virtually intact subtropical reef community (14 phyla, 40 families and 62 non-native taxa) was associated with a rig under tow from Brazil that became stranded on the remote island of Tristan da Cunha. This exposes rigs as a significant vector spreading alien marine organisms, and includes the first records of free-swimming marine finfish populations becoming established after unintentional movement. With relatively trivial effort, a pre-tow clean would have obviated the need to salvage and dispose of the rig (undertaken largely to address concerns about invasive species), at a cost of ~US\$20 million. Our findings show that towing biofouled structures across biogeographic boundaries present unexcelled opportunities for invasion to a wide diversity of marine species. Better control and management of this vector is required urgently. Simultaneous, unintentional introductions of viable populations of multiple marine organisms are rare events, and we develop a basic framework for rapid assessment of invasion risks.

Fernandez, D.A., Ciancio, J., Ceballos, S.G., Riva-Rossi, C., and Pascual, M.A. Chinook salmon (*Oncorhynchus tshawytscha*, Walbaum 1792) in the Beagle Channel, Tierra del Fuego: the onset of an invasion. *Biological Invasions* 12(9): 2991-2997, 2010.

Notes: In this paper we provide the first report of the presence of exotic Chinook salmon (*Oncorhynchus tshawytscha*) in two rivers off the Beagle Channel, Lapataia and Ovando, in southern Tierra del Fuego. We also confirm that successful reproduction occurred in the fall of 2007, as we captured yearlings in freshwater. Scale pattern analyses of adult fish caught were all of the "stream" ecotype, with ages ranging between 3 and 5 (average 4.2 year). Stable isotope analysis of Ovando-Lapataia Chinook population indicates general patterns consistent with those of other populations in the region, but characteristically enriched levels of C indicates a distinct ocean feeding location as compared to Atlantic populations in the Santa Cruz River. Two different haplotypes, one identical to the unique haplotype of the Caterina River population, were found in the Ovando-Lapataia rivers, providing partial evidence for some level of contemporary segregation between these two populations. As an exotic species, Chinook salmon have been able to use the ocean as a waterway to rapidly colonize new habitats both in New Zealand and in several Pacific and Atlantic river basins of continental Patagonia. This record expands the known distribution of this species in Patagonia further south and into the Island of Tierra del Fuego. Its presence in the Beagle Channel creates the conditions for its expansion to a significant collection of new rivers, as well as to adjacent marine areas in and around the Southern Fuegian Channels. Our results provide support to the idea that, in practice, no district of Patagonia is sheltered from the colonization by invasive anadromous salmonids.

Zenetos, A. Trend in aliens species in the Mediterranean. An answer to Galil, 2009 «Taking stock: inventory of alien species in the Mediterranean Sea». *Biological Invasions* 12(9): 3379-3381, 2010.

Notes: The number of marine alien species reported in Galil (*Biol Invasions*, 2009) is incomplete. Recent literature suggests that the number of aliens is nearly 1,000 and that the introduction rate is way off the 10 species per year suggested by Galil (*Biol Invasions*, 2009).

Savini, D., Occhipinti-Ambrogi, A., Marchini, A., Tricarico, E., Gherardi, F., Olenin, S., and Gollasch, S. The top 27 animal alien species introduced into Europe for aquaculture and related activities. *Journal of Applied Ichthyology* 26(Suppl. 2): 1-7, 2010.

Notes: The information extracted from IMPASSE, DAISIE, Fish-Base, and FAO-DIAS inventories of alien species were used to draw a list of the 27 most utilized animal alien species for aquaculture and related activities (e.g. stocking, sport fishing, ornamental purposes) in Europe. Three variables have been considered to assess their negative ecological impacts when these species escape from aquaculture facilities: (i) their distribution across Europe (including non-EU Member States); (ii) evidence of their environmental impact in the wild; and (iii) evidence of their being vectors of non-target alien species and other

hitchhikers (e.g. pathogens). Drivers of use and mechanisms of dispersal in the wild have been also considered and reviewed. Twenty of the species are freshwater fishes: alien cyprinids and salmonids have been introduced into Europe mainly for food production, sport fishing and ornamental purposes. The most widespread species are the goldfish *Carassius auratus* and the rainbow trout *Oncorhynchus mykiss*, established in 29 and 28 European countries, respectively. Notwithstanding their successful distribution in Europe, only the Gibel carp *Carassius gibelio* and the peneid shrimp *Marsupenaeus japonicus* were found to have environmental impact in all the countries of establishment. Crayfish and predatory fishes (e.g. catfishes and salmonids) cause major environmental impacts in Europe by outcompeting native species and altering habitat structure. Alien crayfish, *Procambarus darkii* and *Pacifastacus leniusculus*, are responsible for the largest range of impacts (i.e. crayfish plague dissemination, bioaccumulation of pollutants, community dominance, competition and predation on native species, habitat modifications, food web impairment, herbivory and macrophytes removal). Cyprinids (e.g. herbivorous carps) are vectors of diseases and parasites, while salmonids (e.g. *Salvelinus fontinalis*) often cause genetic impairment of native stocks by hybridization. The importation of alien farmed (target) species frequently leads to the introduction of associated non-target species. The cultures of the Pacific cupped oyster *Crassostrea gigas* and Manila clam *Ruditapes philippinarum* were responsible for the introduction of the largest number (60) of non-native invertebrates and algae, often attached to packaging material, fouling the shell or parasitizing bivalve tissues.

Carman, M.R., Morris, J.A., Karney, R.C., and Grunden, D.W. An initial assessment of native and invasive tunicates in shellfish aquaculture of the North American east coast. *Journal of Applied Ichthyology* 26(Suppl. 2): 8-11, 2010.

Notes: The objective of the study was to assess the distribution of native and invasive tunicates in the fouling community of shellfish aquaculture gear along the U.S. east coast of the Atlantic. Since the 1980s, several species of invasive tunicates have spread throughout the coastal waters of the North American east coast and have become dominant fouling organisms on docks, boat hulls, mooring lines, and in shellfish aquaculture. Invasive and native tunicates negatively impact shellfish aquaculture through increased maintenance costs and reduced shellfish growth. While the presence of alien tunicates has been well documented at piers, harbors, and marinas, there are few published reports of invasive tunicate impacts to aquaculture. We surveyed shellfish aquaculture operations at Martha's Vineyard, Massachusetts and shellfish aquaculturists in other areas along the North American east coast and report high levels of fouling caused by seven invasive, three native, and two cryptogenic species of tunicates. All study sites were fouled by one or more tunicate species. Biofouling control treatments varied among aquaculture sites and were effective in removing tunicates. Invasive and native tunicates should be considered when assessing the economic impacts of fouling organisms to the aquaculture industry.

Davis, M.H. and Davis, M.E. The impact of the ascidian *Styela clava* Herdman on shellfish farming in the Bassin de Thau, France. *Journal of Applied Ichthyology* 26(Suppl. 2): 12-18, 2010.

Notes: The solitary ascidian *Styela clava* Herdman, 1882 has recently been found in the Bassin de Thau, on the French Mediterranean coast, an area of intensive oyster and mussel farming. *S. clava* has the potential to greatly reduce oyster production in the Bassin de Thau by competing with the oysters for food. An understanding of how this species arrived in the Bassin de Thau and why the population growth is limited at present may provide clues to suitable management options to prevent its further spread. The potential impact of *S. clava* on the wider Mediterranean shellfish industry is considered.

Britayev, T.A., Rzhavsky, A.V., Pavlova, L.V., and Dvoretckij, A.G. Studies on impact of the alien red king crab (*Paralithodes camtschaticus*) on the shallow water benthic communities of the Barents Sea. *Journal of Applied Ichthyology* 26(Suppl. 2): 66-73, 2010.

Notes: The red king crab *Paralithodes camtschaticus* (Tilesius, 1815) was introduced in the Barents Sea from the North Pacific in 1961-1969 to establish a fishery. Currently the crab inhabits an area from Kolguyev Island in the east to Soroya in the west, and the total number of adults exceeds 40 million. The crab is a large generalist predator, so its potential impact on native bottom communities is expected to be high. The goal of this study was to review our publications related to the possible impact of the red king crab on the shallow water benthic communities of the Kola Peninsula inlets. First, we reviewed field

and experimental data on feeding ecology of different size groups of the crab. Secondly, we examined the data on the benthic communities' structure in the bays. Finally, assess possible changes in the community structure caused by the red king crab predation. The crab diet includes about 100 species of invertebrates, algae, and fish remnants. Diet of juveniles varied in three studied areas, but bivalve and gastropod mollusks dominated. Experiments on the juvenile feeding showed their positive selection for ophiuroids. Caught prey was usually not completely consumed. Food losses decreased from 50 to 60% in crabs with 35-40 mm carapace width (CW) to 25% in crabs with 70-80 mm CW. Within and between bays trends in the benthic community structure related to the crab density were revealed. Generally, proportion of the stations with disturbed community structure decreased eastward from 80% in the Kola Bay to 18% in the Dolgaja Bay and it was negligible in the Dal'nezelenzkaja Bay. This pattern coincides with the juvenile crab density decreasing eastward. On a smaller scale in the Kola Bay we observed a negative correlation between biomass of macrozoobenthos and juvenile crab density, which was likely related to the crab predation. Comparison of the new data obtained in 2006 with the detailed survey of soft bottom macrobenthos conducted in 1990 in Dolgaja Bay showed a decrease of the diversity of soft bottom communities as well as in species richness, density and biomass of bivalves. Our data demonstrate that the proposed impact of the crab on the bottom communities of the Barents Sea is not as dramatic as have been expected from its high feeding activity and wide diet. We hypothesize that the crab omnivory distributes its predation pressure among various groups of organisms and prevents elimination of particular species or taxa.

Kangur, A., Kangur, P., Kangur, K., Jarvalt, A., and Haldna, M. *Anguillicoloides crassus* infection of European eel, *Anguilla anguilla* (L.), in inland waters of Estonia: history of introduction, prevalence and intensity. *Journal of Applied Ichthyology* 26(Suppl. 2): 74-80, 2010.

Notes: Eel fishery in Estonian inland waters depends entirely on the stocking of glass eels or pre-grown (farmed) eels. Via importation of live eels of 20-30 cm length the non-indigenous swimbladder nematode *Anguillicoloides crassus* was probably introduced via Germany into Lake Võrtsjärv in 1988, and has since spread to many inland waters of Estonia. In 1992, the parasite was found in eel caught from Lake Võrtsjärv. Between 1992 and 2002 and additionally in 2008, we examined in total 870 eels from Lake Võrtsjärv (270 km²) and in 2008, 63 eels from three small lakes for adult *A. crassus*. The aim of the study was to obtain information on the variation of *A. crassus* infection in eels in Estonian lakes, to determine the temporal dynamics of prevalence and intensity of infection, and to establish a relationship between the length of host and intensity of infection in the eels in Lake Võrtsjärv. There appeared to be a pronounced variation in prevalences of infected eels (from 3.7% to 100%) between the four investigated lakes. However, in Lake Võrtsjärv, the prevalence of adult *A. crassus* infection remained stable (mean about 65%) for many years. The average number of nematode per infected eel (mean intensity) ranged from 12.6 ± 2.5 in 1993 to 4.0 ± 0.6 in 1999 in Lake Võrtsjärv, while it was significantly higher ($P < 0.0001$) in the period 1992-1998 compared to 1999-2002 and 2008. The mean number of parasites per swimbladder was not related to eel length and no statistical difference was found in the condition factor of infected and non-infected eels. Although under normal environmental conditions *A. crassus* has not caused serious disease problems to eels in the study area, high intensity of parasite infection may contribute to eel kills due to oxygen deficiency in winter under the ice in Lake Võrtsjärv.
