

In this review:

- A. Recent articles – no abstract available
- B. Recent articles with abstracts

A. Recent articles – no abstract available

Firestone, J. **Dilemmas and dimensions of non-indigenous organisms and pathogens in the marine environment: A sea change.** *Journal of International Wildlife Law and Policy* 9(1): 123-132, 2006.

B. Recent articles with abstracts

Strayer, D.L., Eviner, V.T., Jeschke, J.M., and Pace, M.L. **Understanding the long-term effects of species invasions.** *Trends in Ecology and Evolution* 21(11): 645-651, 2006.

Notes: We describe here the ecological and evolutionary processes that modulate the effects of invasive species over time, and argue that such processes are so widespread and important that ecologists should adopt a long-term perspective on the effects of invasive species. These processes (including evolution, shifts in species composition, accumulation of materials and interactions with abiotic variables) can increase, decrease, or qualitatively change the impacts of an invader through time. However, most studies of the effects of invasive species have been brief and lack a temporal context; 40% of recent studies did not even state the amount of time that had passed since the invasion. Ecologists need theory and empirical data to enable prediction, understanding and management of the acute and chronic effects of species invasions.

Pasternak, Z., Diamant, A., and Abelson, A. **Co-invasion of a Red Sea fish and its ectoparasitic monogenean, *Polylabris cf. mamaevi* into the Mediterranean: observations on oncomiracidium behavior and infection levels in both seas.** *Parasitology Research* 100(4): 721-727, 2007.

Notes: This study investigated aspects of the biology of the monogenean gill ectoparasite *Polylabris cf. mamaevi* (Polyopisthocotylea: Microcotyleae) infecting rabbitfish, *Siganus rivulatus* (Forsk.) (Teleostei: Siganidae). Both host and parasite are Lessepsian immigrants that have co-invaded the Mediterranean Sea via the Suez Canal. The infection prevalence and mean intensity of the polyopisthocotylean was examined in both native and immigrant host populations and found to be three times greater in the new biogeographical region. In vitro observations on parasite eggs from both areas indicated that hatching occurred almost exclusively in the dark. The reaction of the larval oncomiracidia to water flow and secreted host chemicals indicated that neither Red Sea nor Mediterranean oncomiracidia exposed to waterborne host metabolites displayed any significant response or change in behavior; however, upon encountering flow, they ceased to swim and drifted passively downstream. Host specificity of *P. cf. mamaevi* may have co-evolved with temporal synchronization of the parasite with the host's diurnal activity. Hatching of *P. cf. mamaevi* eggs was rhythmical and the timing coincided with the known nocturnal resting behavior of the hosts, when their schools lie immobile on the sea bottom. After hatching, abrupt cessation of active swimming by the oncomiracidia upon sensing host inhalant gill-ventilating currents is likely to facilitate rapid, passive entry into the gill chamber of a suitable host. The greater abundance of *P. cf. mamaevi* in the invading (Mediterranean) populations is probably due to the changed, new environment, possibly impacting host resistance to the parasite and encouraging heavier infections.

Keller, R.P., Lodge, D.M., and Finnoff, D.C. **Risk assessment for invasive species produces net bioeconomic benefits.** *Proceedings of the National Academy of Sciences [USA]* 104(1): 203-207, 2007.

Notes: International commerce in live organisms presents a policy challenge for trade globalization; sales of live organisms create wealth, but some nonindigenous species cause harm. To reduce damage, some countries have implemented species screening to limit the introduction of damaging species. Adoption of new risk assessment (RA) technologies has been slowed, however, by concerns that RA accuracy remains insufficient to produce positive net economic benefits. This concern arises because only a small proportion of all introduced species escape, spread, and cause harm (i.e., become invasive), so a RA will exclude many noninvasive species (which provide a net economic benefit) for every invasive species correctly identified. Here, we develop a simple cost:benefit bioeconomic framework to quantify the net benefits from applying species prescreening. Because invasive species are rarely eradicated, and their damages must therefore be borne for long periods, we have projected the value of RA over a suitable range of policy time horizons (10-500 years). We apply the model to the Australian plant quarantine program and show that this RA program produces positive net economic benefits over the range of reasonable assumptions. Because we use low estimates of the financial damage caused by invasive species and high estimates of the value of species in the ornamental trade, our results underestimate the net benefit of the Australian plant quarantine program. In addition, because plants have relatively low rates of invasion, applying screening protocols to animals would likely demonstrate even greater benefits.

Perez, J.E., Alfonsi, C., Nirchio, M., and Barrios, J. **The inbreeding paradox in invasive species.** *Interciencia* 31(7): 544-546, 2006.

Notes: One of the most relevant topics in the biology of invasion concerns an inbreeding paradox: how do exotic species that usually invade new territories in small numbers, thus suffering the affects of inbreeding, become successful invaders. To explain this paradox, it has been argued that high migration rates and repeated introductions of exotic species take place so as to overcome low genetic diversity and inbreeding. However, several single episodes of exotic species introduction have occurred that cannot be explained by this hypothesis. An attempt is made to solve this paradox by considering that invaders are not only able to modify the new environment, but also suffer modifications under the influence of the new environment. The possible role of epigenetic adaptations and adaptive mutations is postulated in order to explain the successful adaptation of invaders in their new environment.

Hoagland, P. and Jin, D. **Science and economics in the management of an invasive species.** *BioScience* 56(11): 931-935, 2006.

Notes: Estimates of the economic impacts of nonnative nuisance ("invasive") species must rely on both a sound ecological understanding and the proper application of economic methods. Focusing on the example of the invasive European green crab (*Carcinus maenas*), we show that the crab's estimated economic impact - which has been used to help justify recent public policy - is based on data taken from the wrong geographic location. Furthermore, the predictions of ecological effects appear to rest on loose footing, and economic methods have been misapplied in constructing the estimate. Our purpose is to call attention to the need for the more careful application of science and economics in managing this pressing environmental issue.

Arenas, F., Sanchez, I., Hawkins, S.J., and Jenkins, S.R. **The invisibility of marine algal assemblages: Role of functional diversity and identity.** *Ecology* 87(11): 2851-2861, 2006.

Notes: The emergence of the biodiversity-ecosystem functioning debate in the last decade has renewed interest in understanding why some communities are more easily invaded than others and how the impact of invasion on recipient communities and ecosystems varies. To date most of the research on invisibility has focused on taxonomic diversity, i.e., species richness. However, functional diversity of the communities should be more relevant for the resistance of the community to invasions, as the extent of functional differences among the species in an assemblage is a major determinant of

ecosystem processes. Although coastal marine habitats are among the most heavily invaded ecosystems, studies on community invasibility and vulnerability in these habitats are scarce. We carried out a manipulative field experiment in tide pools of the rocky intertidal to test the hypothesis that increasing functional richness reduces the susceptibility of macroalgal communities to invasion. We selected a priori four functional groups on the basis of previous knowledge of local species characteristics: encrusting, turf, subcanopy, and canopy species. Synthetic assemblages containing one, two, three, or four different functional groups of seaweeds were created, and invasion by native species was monitored over an eight-month period. Cover and resource availability in the assemblages with only one functional group showed different patterns in the use of space and light, confirming true functional differences among our groups. Experimental results showed that the identity of functional groups was more important than functional richness in determining the ability of macroalgal communities to resist invasion and that resistance to invasion was resource-mediated.

Schaffelke, B., Smith, J.E., and Hewitt, C.L. **Introduced macroalgae - a growing concern.** *Journal of Applied Phycology* 18(3-5): 529-541, 2006.

Notes: Introductions of non-indigenous species to new ecosystems are one of the major threats to biodiversity, ecosystem functions and services. Globally, species introductions may lead to biotic homogenisation, in synergy with other anthropogenic disturbances such as climate change and coastal pollution. Successful marine introductions depend on (1) presence of a transport vector, uptake of propagules and journey survival of the species; (2) suitable environmental conditions in the receiving habitat; and (3) biological traits of the invader to facilitate establishment. Knowledge has improved of the distribution, biology and ecology of high profile seaweed invaders, e.g. *Caulerpa taxifolia*, *Codium fragile* ssp. *tomentosoides*, *Sargassum muticum*, and *Undaria pinnatifida*. Limited, regional information is available for less conspicuous species. The mechanisms of seaweed introductions are little understood as research on introduced seaweeds has been mostly reactive, following discoveries of introductions. Sources of introductions mostly cannot be determined with certainty apart from those directly associated with aquaculture activities and few studies have addressed the sometimes serious ecological and economic impacts of seaweed introductions. Future research needs to elucidate the invasion process, interactions between invaders, and impacts of introductions to support prevention and management of seaweed introductions.

Hammer, M.P. **Range extensions for four estuarine gobies (Pisces: Gobiidae) in southern Australia: Historically overlooked native taxa or recent arrivals?** *Transactions of the Royal Society of South Australia* 130: 187-196, 2006.

Notes: Targeted sampling for gobiid fishes in the Port River estuarine system adjacent to Adelaide, South Australia, identified four previously unrecorded species. Significant range extensions along the east-west coastline of southern Australia are reported for the Australian endemic flatback mangrove goby *Mugilogobius platynotus* (Gunther, 1861), largemouth goby *Redigobius macrostoma* (Gunther, 1861) and Kreff's frill goby *Bathygobius krefftii* (Steindachner, 1866) plus the alien Trident goby *Tridentiger trigonocephalus* (Gill, 1859). Moreover, *M. platynotus*, *R. macrostoma* and *T. trigonocephalus* are new records to the fish fauna of the state of South Australia. While it is clear that *T. trigonocephalus* has invaded another southern Australian port, there is difficulty in determining the status of the three Australian endemics as being either native to the area or recent introductions (e.g. through ship mediated translocation) due to a previous paucity of sampling and the cryptic nature of goby behaviour that may have prevented historic detection. The long-term existence of suitable habitat on the one hand suggests that these populations are naturally occurring in the Port River. However, a drastically altered estuarine environment, the high incidence of other translocated marine organisms in the system and goby biological traits suiting transportation in ship ballasts or hull fouling conversely casts doubts over their origin. Contrasting management scenarios of conservation versus potential eradication for these newly discovered species highlights a dilemma for biodiversity conservation in an altered environment.

Giberto, D.A., Bremec, C.S., Schejter, L., Schiariti, A., Mianzan, H., and Acha, E.M. **The invasive rapa whelk *Rapana venosa* (Valenciennes 1846): Status and potential ecological impacts in the Rio de la Plata estuary, Argentina-Uruguay.** *Journal of Shellfish Research* 25(3): 919-924, 2006.

Notes: Recent range extensions of the invasive rapa whelk *Rapana venosa*, biological data of the population and possible ecological impacts on the food webs of the Rio de la Plata estuary are presented. A total of 41 rapa whelks and 21 egg capsules were collected between February 2004 and March 2006. Specimens were found all over the mixohaline waters of the estuary,

with records off Montevideo, Samborombon Bay and off Punta Rasa. Specimens ranged between 28 and 120 mm shell length. Almost all *R. vellosa* presented epibionts all over the shell, suggesting an exposed lifestyle. Egg-masses were attached to specimens of *R. venosa*, debris and plastic garbage. The spatial distribution of *R. venosa* within the estuary was coupled with the spatial distribution of *Macra isabelleana*, a typical subtidal bivalve of mixohaline waters. The implications for the food webs of the estuary, including possible predators, are discussed. The presence of *R. venosa* in muddy sediments together with the finding of egg-capsules over the specimens, and the low salinity values at which it is found in the Rio de la Plata estuary, confirmed the high plasticity of *R. venosa* and the potential capability of successfully invading novel environments.

Hastings, A., Hall, R.J., and Taylor, C.M. **A simple approach to optimal control of invasive species.** *Theoretical Population Biology* 70(4): 431-435, 2006.

Notes: The problem of invasive species and their control is one of the most pressing applied issues in ecology today. We developed simple approaches based on linear programming for determining the optimal removal strategies of different stage or age classes for control of invasive species that are still in a density-independent phase of growth. We illustrate the application of this method to the specific example of invasive *Spartina alterniflora* in Willapa Bay, WA. For all such systems, linear programming shows in general that the optimal strategy in any time step is to prioritize removal of a single age or stage class. The optimal strategy adjusts which class is the focus of control through time and can be much more cost effective than prioritizing removal of the same stage class each year.

Witmer, G., Burke, P., Jajola, S., and Dunlevy, P. **The biology of introduced Norway rats on Kiska Island, Alaska, and an evaluation of an eradication approach.** *Northwest Science* 80(3): 191-198, 2006.

Notes: Introduced, invasive rats can cause substantial damage to native flora and fauna, including ground-nesting seabirds, when they become established on islands. We tested a control method for introduced Norway rats on Kiska Island, Alaska, during April-May, 2004, by hand-broadcasting rodenticide pellets (0.005% diaphacinone) over a 4-ha area at the rate of 28 kg/ha. We also gathered data on aspects of rat ecology and distribution, although rats were difficult to detect and capture. The rodenticide bait pellets seemed to have been effective in reducing the Norway rat population, however, this is based on a limited observation of rat sign and captures. Four rats were captured on elevational transects on the northside of the island, all below 20 m elevation. Twelve rats captured in other aspects of the study also came from lower elevations. Rat stomach contents revealed that vegetation and seabirds were important components of the diet at the north end of Kiska Island, but stomach contents varied by location depending upon the type of food most readily available. All eight females captured were pregnant and bore an average of 10 embryos. Although the control or eradication of rats at remote locations such as the Aleutian Islands is theoretically possible, there are many challenges posed to resource managers. This field study has provided insight into the ecology and management of Norway rats at Kiska Island, but also points out some of the challenges that remain.

Lodge, D.M., Williams, S., MacIsaac, H.J., Hayes, K.R., Leung, B., Reichard, S., Mack, R.N., Moyle, P.B., Smith, M., Andow, D.A., Carlton, J.T., and McMichael, A. **Biological invasions: Recommendations for US policy and management.** *Ecological Applications* 16(6): 2035-2054, 2006.

Notes: The Ecological Society of America has evaluated current U.S. national policies and practices on biological invasions in light of current scientific knowledge. Invasions by harmful nonnative species are increasing in number and area affected; the damages to ecosystems, economic activity, and human welfare are accumulating. Without improved strategies based on recent scientific advances and increased investments to counter invasions, harm from invasive species is likely to accelerate. Federal leadership, with the cooperation of state and local governments, is required to increase the effectiveness of prevention of invasions, detect and respond quickly to new potentially harmful invasions, control and slow the spread of existing invasions, and provide a national center to ensure that these efforts are coordinated and cost effective. Specifically, the Ecological Society of America recommends that the federal government take the following six actions: (1) Use new information and practices to better manage commercial and other pathways to reduce the transport and release of potentially harmful species; (2) Adopt more quantitative procedures for risk analysis and apply them to every species proposed for importation into the country; (3) Use new cost-effective diagnostic technologies to increase active surveillance and sharing of information about invasive

species so that responses to new invasions can be more rapid and effective; (4) Create new legal authority and provide emergency funding to support rapid responses to emerging invasions; (5) Provide funding and incentives for cost-effective programs to slow the spread of existing invasive species in order to protect still uninvaded ecosystems, social and industrial infrastructure, and human welfare; and (6) Establish a National Center for Invasive Species Management (under the existing National Invasive Species Council) to coordinate and lead improvements in federal, state, and international policies on invasive species. Recent scientific and technical advances provide a sound basis for more cost-effective national responses to invasive species. Greater investments in improved technology and management practices would be more than repaid by reduced damages from current and future invasive species. The Ecological Society of America is committed to assist all levels of government and provide scientific advice to improve all aspects of invasive-species management.

McGee, S., Piorkowski, R., and Ruiz, G. **Analysis of recent vessel arrivals and ballast water discharge in Alaska: Toward assessing ship-mediated invasion risk.** *Marine Pollution Bulletin* 52(12): 1634-1645, 2006.

Notes: Ships are a dominant vector for biological invasions through ballast water discharge (BWD) and hull fouling. Here, we provide a first comprehensive analysis of shipping in Alaska, summarizing (a) the number, type and origin of vessel arrivals to Alaska for 2003 and 2004, (b) the spatial and temporal variation in vessel traffic, and (c) the available data on ballast water discharge in order to prioritize locations for tracking biological invasions. Most arrivals were passenger vessels, followed by ferries and fishing vessels, all of which carried little ballast water. Regional and seasonal patterns in arrivals and BWD were unevenly distributed among vessel types. The majority of vessels reporting BWD were from foreign ports, and most of this ballast was untreated. The largest volumes of ballast were from tankers at Valdez and Kenai Peninsula ports. Although Alaska has few documented invasions, opportunities for ship-mediated transfer now appear high and warrant further scrutiny.

Qian, H. and Ricklefs, R.E. **The role of exotic species in homogenizing the North American flora.** *Ecology Letters* 9(12): 1293-1298, 2006.

Notes: Exotic species have begun to homogenize the global biota, yet few data are available to assess the extent of this process or factors that constrain its advance at global or continental scales. We evaluate homogenization of vascular plants across America north of Mexico by comparing similarity in the complete native and exotic floras between states and provinces of the USA and Canada. Compared with native species, exotic plants are distributed haphazardly among areas but spread more widely, producing differentiation of floras among neighbouring areas but homogenization at greater distance. The number of exotic species is more closely associated with the size of the human population than with ecological conditions, as in the case of native species, and their distributions are less influenced by climate than those of native species.

Fukami, T., Wardle, D.A., Bellingham, P.J., Mulder, C.P.H., Towns, D.R., Yeates, G.W., Bonner, K.I., Durrett, M.S., Grant-Hoffman, M.N., and Williamson, W.M. **Above- and below-ground impacts of introduced predators in seabird-dominated island ecosystems.** *Ecology Letters* 9(12): 1299-1307, 2006.

Notes: Predators often exert multi-trophic cascading effects in terrestrial ecosystems. However, how such predation may indirectly impact interactions between above- and below-ground biota is poorly understood, despite the functional importance of these interactions. Comparison of rat-free and rat-invaded offshore islands in New Zealand revealed that predation of seabirds by introduced rats reduced forest soil fertility by disrupting sea-to-land nutrient transport by seabirds, and that fertility reduction in turn led to wide-ranging cascading effects on belowground organisms and the ecosystem processes they drive. Our data further suggest that some effects on the belowground food web were attributable to changes in aboveground plant nutrients and biomass, which were themselves related to reduced soil disturbance and fertility on invaded islands. These results demonstrate that, by disrupting across-ecosystem nutrient subsidies, predators can indirectly induce strong shifts in both above- and below-ground biota via multiple pathways, and in doing so, act as major ecosystem drivers.

Melbourne, B.A., Cornell, H.V., Davies, K.F., Dugaw, C.J., Elmendorf, S., Freestone, A.L., Hall, R.J., Harrison, S., Hastings, A., Holland, M., Holyoak, M., Lambrinos, J., Moore, K., and Yokomizo, H. **Invasion in a heterogeneous world:**

resistance, coexistence or hostile takeover? *Ecology Letters* 10(1): 77-94, 2007.

Notes: We review and synthesize recent developments in the study of the invasion of communities in heterogeneous environments, considering both the invasibility of the community and impacts to the community. We consider both empirical and theoretical studies. For each of three major kinds of environmental heterogeneity (temporal, spatial and invader-driven), we find evidence that heterogeneity is critical to the invasibility of the community, the rate of spread, and the impacts on the community following invasion. We propose an environmental heterogeneity hypothesis of invasions, whereby heterogeneity both increases invasion success and reduces the impact to native species in the community, because it promotes invasion and coexistence mechanisms that are not possible in homogeneous environments. This hypothesis could help to explain recent findings that diversity is often increased as a result of biological invasions. It could also explain the scale dependence of the diversity-invasibility relationship. Despite the undoubted importance of heterogeneity to the invasion of communities, it has been studied remarkably little and new research is needed that simultaneously considers invasion, environmental heterogeneity and community characteristics. As a young field, there is an unrivalled opportunity for theoreticians and experimenters to work together to build a tractable theory informed by data.

Xu, H.G., Ding, H., Li, M.Y., Qiang, S., Guo, J.Y., Han, Z.M., Huang, Z.G., Sun, H.Y., He, S.P., Wu, H. R., and Wan, F.H. **The distribution and economic losses of alien species invasion to China.** *Biological Invasions* 8(7): 1495-1500, 2006.

Notes: Invasive alien species have become one of the most serious environmental issues in the world. Data of taxon, origin, pathway, and environmental impacts of invasive alien microorganisms, invertebrates, amphibians and reptiles, fish, birds, mammals, herbs, trees, and marine organisms in terrestrial, aquatic, and marine ecosystems of China were analyzed during 2001 and 2003, based on literature retrieval and field survey. There were 283 invasive alien species in China, and the number of species of invasive alien microorganisms, aquatic plants, terrestrial plants, aquatic invertebrates, terrestrial invertebrates, amphibians and reptiles, fish, and mammals were 19, 18, 170, 25, 33, 3, 10, and 5, respectively. The proportion of invasive alien species originated from America, Europe, Asia, Africa, and Oceania were 55.1, 21.7, 9.9, 8.1, and 0.6%, respectively. Methods for estimation of direct economic losses to agriculture, forestry, stockbreeding, fishery, road and water transportation, storage, water conservancy, environment and public facilities, and human health were established. Methods for estimation of indirect economic losses caused by invasive alien species to service functions of forest ecosystems, agricultural ecosystems, grassland ecosystems, and wetland ecosystems were also established. The total economic losses caused by invasive alien species to China were to the time of USD 14.45 billion, with direct and indirect economic losses accounting for 16.59% and 83.41% of total economic losses, respectively

Wang, Q., Wang, C.H., Zhao, B., Ma, Z.J., Luo, Y.Q., Chen, J.K., and Li, B. **Effects of growing conditions on the growth of and interactions between salt marsh plants: Implications for invasibility of habitats.** *Biological Invasions* 8(7): 1547-1560, 2006.

Notes: A common but often less tested explanation for the successful invasion of alien species is that invasive alien species outcompete their co-occurring natives, which may not always be the case. In this study, we established artificial environmental gradients in a series of pot experiments with controlled environments to investigate the effects of salinity, sediment type and waterlogging on the performance of and interactions between *Phragmites australis* (native) and *Spartina alterniflora* (alien), which generally co-exist in the saline intertidal zones of Chinese and American coasts. Significant effects of salinity and waterlogging were detected on biomass production and morphological characteristics of *S. alterniflora* and *P. australis*, and the competitive interactions between the two species were found to vary with all three environmental factors in our experiments. Relative Neighbor Effect (RNE) analyses indicate that competitive dominance of *S. alterniflora* occurred under the conditions of high salinity, sandy sediment and full immersion, whereas *P. australis* showed competitive dominance under the conditions of low salinity and non-immersion. Our results suggest that *S. alterniflora* might outcompete *P. australis* under conditions present in early salt marsh succession, which support the viewpoint that the outcomes of competition between co-occurring native and invasive alien plants depend on the growing conditions. The implication of this study is that in response to the environmental changes expected from seawater intrusion and sea-level rise, the range of *S. alterniflora* is expected to expand further in the Yangtze River estuary in the future.

Thieltges, D.W., Strasser, M., and Reise, K. **How bad are invaders in coastal waters? The case of the American slipper limpet *Crepidula fornicata* in western Europe.** *Biological Invasions* 8(8): 1673-1680, 2006.

Notes: Introduced species are assumed to exert a variety of negative ecological effects in their new environments. However, rigid studies on such effects are still rare. Using a case study we exemplify pitfalls and obstacles for research on ecological effects of invaders and highlight the need for a concise framework. The suspension feeding gastropod *Crepidula fornicata* was accidentally introduced with American oysters to Europe and was soon after defamed as an 'oyster pest' although no evidence was provided in justification. Recently, small-scale experiments with *C. fornicata* and the Pacific oyster *Crassostrea gigas* failed to prove competition. As an epizootic, however, *C. fornicata* is impeding native mussels *Mytilus edulis* but at the same time provides protection against starfish predation. It also may serve as a sink for infectious trematode parasites and hence be beneficial for bivalve basibionts. Another positive effect of *C. fornicata*, especially at the coast of France where it is superabundant, may be that it causes a shift of phytoplankton blooms from toxic flagellates to diatoms. The multiple interactions with recipient coastal ecosystems result in a complex interplay of negative as well as positive effects of the invader on native biota. Positive effects of invaders might occur with the same frequency as negative ones, and the general prejudice that introduced species exert *per se* a negative effect may dictate the outcome of research. We argue that considering both, negative as well as positive effects of an introduced species is needed to eventually enable us to evaluate the overall effect of an invasion on recipient ecosystems. Besides pointing to the importance of positive effects, this case study also shows that research on effects of introduced species should (1) be species specific, (2) consider different spatial scales, (3) clarify which stage of an invasive process is under observation and (4) clearly distinguish between ecological effects, human-relevant impacts and the ethical judgment of both. A concise framework for research on ecological effects of introduced species - which still has to be developed - should incorporate these aspects.

Kollmann, J., Frederiksen, L., Vestergaard, P., and Bruun, H.H. **Limiting factors for seedling emergence and establishment of the invasive non-native *Rosa rugosa* in a coastal dune system.** *Biological Invasions* 9(1): 31-42, 2007.

Notes: The relative importance of seed, habitat and microhabitat limitation has rarely been investigated for invasive non-native species, although this is critical for their effective management and for predicting future range expansion. *Rosa rugosa* is an abundant non-native shrub in coastal habitats of NW Europe; it is common along the Baltic coast but more scarce in exposed dunes of the North Sea. To investigate whether invasion of exposed dunes is limited by seed, habitat and microhabitat limitation, seedling emergence and establishment were examined in a factorial sowing, transplant and disturbance experiment. Twenty plots were randomly placed in each of five dune habitats (white dune, Empetrum dune, grey dune, outer dune heath, inner dune heath), and studied over 2 years. Seedling emergence in control subplots was zero in all habitats, whereas 96% and 98% of the undisturbed and disturbed seeded subplots produced seedlings. Disturbance had a positive effect on emergence and subsequent survival in white dune, outer and inner dune heath. Seedling survival and growth, and growth of transplanted seedlings, were markedly lower in grey dune. These findings indicate that establishment of *R. rugosa* is seed-limited in coastal dune habitats, and that the species is able to establish in both active and fixed dunes once seeds have arrived. Although differential seedling emergence and growth indicate that habitats differ in their degree of invasion susceptibility by *R. rugosa*, the positive influence of small-scale disturbance suggests microhabitat limitation in some dune habitats as well. Dune management should aim to reduce seed production and dispersal of *R. rugosa* in near-natural sites, and anthropogenic changes of habitat dynamics should be prevented.

Whitfield, P.E., Hare, J.A., David, A.W., Harter, S.L., Munoz, R.C., and Addison, C.M. **Abundance estimates of the Indo-Pacific lionfish *Pterois volitans/miles* complex in the Western North Atlantic.** *Biological Invasions* 9(1): 53-64, 2007.

Notes: Less than a decade after being observed off Florida, the invasive Indo-Pacific lionfish is now widely distributed off the southeast coast of the United States. As a step towards measuring invasion impacts to native communities, we examine the magnitude and extent of this invasion by first, compiling reports of lionfish to provide range information and second, estimate lionfish abundance from two separate studies. We also estimate native grouper (*Epinepheline serranids*) abundance to better assess and compare lionfish abundances. In the first study we conducted SCUBA diver visual transect surveys at 17 different locations off the North Carolina coast in water depths of 35 - 50 m. In the second study, we conducted 27 Remote Operated Vehicle (ROV) transect surveys at five locations from Florida to North Carolina in water depths of 50 - 100 m. In both studies, lionfish were found to be second in abundance only to scamp (*Mycteroperca phenax*). Lionfish were found in higher abundance in the shallower North Carolina SCUBA surveys ($-/x = 21.2 \text{ ha}^{-1}$) than in the deep water ROV surveys ($-/x = 5.2$

ha⁻¹). Lionfish reports continue to expand most recently into the Bahamas, raising the specter of further spread into the Caribbean and Gulf of Mexico. The potential impacts of lionfish to native communities are likely to be through direct predation, competition and overcrowding. The high number of lionfish present in the ecosystem increases the potential for cascading impacts throughout the food chain. Within the southeast region the combined effects of climate change, overfishing and invasive species may have irreversible consequences to native communities in this region.

Duggan, I.C., Bailey, S.A., van Overdijk, C.D.A., and MacIsaac, H.J. **Invasion risk of active and diapausing invertebrates from residual ballast in ships entering Chesapeake Bay.** *Marine Ecology Progress Series* 324: 57-66, 2006.

Notes: We examined the invasion risk posed by active invertebrates and their diapausing stages (e.g. resting eggs, quiescent adults) carried in residual sediment and water of non-ballasted ships to Chesapeake Bay. Many taxa were recorded that are not native to Chesapeake Bay, supporting the contention that residual ballast represents an invasion vector of some risk to marine systems. Composition and propagule supply differed relative to that in ships entering the Laurentian Great Lakes (e.g. marine taxa dominated in Chesapeake Bay ships), indicating that risk varies geographically. Average abundances of active invertebrates in residual sediment (1002.1 ind. kg⁻¹) and water (2.7 ind. l⁻¹), and diapausing eggs in sediments (779.4 eggs kg⁻¹), were typically low relative to those in ships entering the Great Lakes (1322.5 ind. kg⁻¹, 10.9 ind. l⁻¹ and 3650.0 eggs kg⁻¹, respectively). However, due to high variability among ships, differences were not statistically significant. The major cause of composition and abundance differences is dissimilar trade routes between each system, with vessels entering Chesapeake Bay primarily originating from marine rather than freshwater ports, and because diapausing stages are less commonly found among marine invertebrates. Low propagule supplies, predominant intra-continental ship movements, and salinity disparity between the upper (20 to 28 parts per thousand) and lower (3 to 8 parts per thousand) regions of Chesapeake Bay (where ballast water is loaded and offloaded) may greatly reduce invasion risk and be a contributing factor to the bay's low invasion rate: invasion risk from non-ballasted ships here may be low relative to hull fouling or ballast water discharge. Other marine coastal areas may be at greater risk from this vector.

Kimmerer, W.J. **Response of anchovies dampens effects of the invasive bivalve *Corbula amurensis* on the San Francisco Estuary foodweb.** *Marine Ecology Progress Series* 324: 207-218, 2006.

Notes: Introduced bivalves have suppressed phytoplankton production in many aquatic foodwebs, but effects on higher trophic levels have been inconsistent. In the northern San Francisco Estuary, the introduced clam *Corbula amurensis* eliminated summer-long phytoplankton blooms starting in 1987, but responses of mesozooplankton biomass and most fish were somewhat muted. I conducted a retrospective analysis of the response of the estuarine foodweb to the decline in phytoplankton due to clam grazing. When *C. amurensis* invaded, the distribution of northern anchovy *Engraulis mordax* shifted toward higher salinity, reducing summer abundance by 94% in the low-salinity region of the estuary. Northern anchovy dominates the biomass of fish in the more saline reaches of the estuary, and is genetically affiliated with the subpopulation on the central California coast, which in turn is strongly influenced by climate variability. However, abundance of northern anchovy within the estuary was not related to available estimates of biomass, catch, or abundance of northern anchovy on the California coast, nor was it related to any of 4 variables describing aspects of climate variability with different time and space scales. The shift in spatial distribution appears to have been a direct behavioral response to reduced food. Bioenergetic calculations showed reduced consumption of zooplankton by all planktivores, including mysids, after *C. amurensis* became abundant and the anchovy left the low-salinity region of the estuary. This reduced consumption appears to have mitigated effects of the loss of phytoplankton productivity, making a greater proportion of the zooplankton productivity available to other fish species. Such behavioral accommodations are likely wherever invasions occur in open systems.

Bouley, P. and Kimmerer, W.J. **Ecology of a highly abundant, introduced cyclopoid copepod in a temperate estuary.** *Marine Ecology Progress Series* 324: 219-228, 2006.

Notes: The cyclopoid copepod *Limnithona tetraspina* (Oithonidae) was introduced into the San Francisco Estuary (SFE) in 1993 and within a year became the most abundant copepod in the low-salinity zone. *L. tetraspina* makes up ~ 95% (median) of the total adult copepods in the low-salinity zone, and the biomass of adults is similar to that of 2 larger co-occurring calanoids, *Pseudodiaptomus forbesi* and *Eurytemora affinis*. The main goal of our research was to understand which food resources *L. tetraspina*

uses in the low-salinity region of the SFE. Incubation experiments using natural water revealed feeding by *L. tetraspina* on mixotrophic and heterotrophic aloricate ciliates, but rarely on loricate tintinnids or diatoms. The co-occurring calanoids consumed similar prey, but also readily consumed diatoms. Capture and consumption of *Strombidium* spp. by *L. tetraspina* was confirmed visually, and experiments using cultured prey also showed that these copepods fed on motile phytoplankton but not on diatoms. Estimated grazing rates were low (median 2.3, range 0.6 to 8.3% body weight d⁻¹); although these rates may be underestimates because of high concentrations of copepods in experimental containers, they are consistent with low specific egg production of females (0.3 ± 0.2% body weight d⁻¹). Low selectivity of one fish species for *L. tetraspina* suggests that this copepod may not be an important food resource for visually-selective fishes in the SFE. The low abundance of filter-feeding predators in this region of the estuary may be responsible for the high abundance of this cyclopoid copepod, despite its low potential population growth rate.

Scheibling, R.E. and Gagnon, P. **Competitive interactions between the invasive green alga *Codium fragile* ssp *tomentosoides* and native canopy-forming seaweeds in Nova Scotia (Canada).** *Marine Ecology Progress Series* 325: 1-14, 2006.

Notes: Two concurrent 2 yr experiments were conducted along the Atlantic coast of Nova Scotia (1) to examine competitive interactions between the invasive green alga *Codium fragile* ssp. *tomentosoides* and canopy-forming native seaweeds, particularly the dominant kelps (*Laminaria longicruris* and *L. digitata*) and opportunistic algae (*Desmarestia viridis* and *D. aculeata*), and (2) to identify conditions enabling the establishment and persistence of *C. fragile*. In the first experiment, *Laminaria* spp. and/or *Desmarestia* spp. were either removed or left intact (in an orthogonal factorial design) to examine their effect on *C. fragile*. At the end of the experiment, cover, density, and biomass of *C. fragile* did not differ significantly among treatments, although mean density was up to 2 times greater in plots where kelp was removed than in control plots. While removal of kelp positively affected growth of *C. fragile* (up to 12 cm mo⁻¹) during the first year, growth was similar among treatments in the second year, when kelps were smaller and *Desmarestia* spp. were virtually absent (following decimation of native seaweeds by the invasive bryozoan *Membranipora membranacea*). Survival of marked individuals of *C. fragile* was high in all treatments in the first year (85 to 100%), but dropped during winter in the second year (40 to 60%). In the second experiment, the effect of stands of *C. fragile* on recolonization by *Laminaria* spp. and *Desmarestia* spp. was examined by removing *C. fragile* in both Pulse and Press removal treatments. At the end of the experiment, density of *Laminaria* spp. in the Press treatment was more than 4 times higher than in the Pulse treatment. Dense stands of *C. fragile* in control plots inhibited recruitment of kelps and other seaweeds, and survival of marked thalli of *C. fragile* over 9 mo was high (90%). We conclude *C. fragile* exhibits competitive advantages over native seaweeds through opportunistic exploitation of disturbance-generated gaps within kelp beds. Once established as dense meadows, *C. fragile* prevents re-colonization by kelp and persists as the dominant canopy-forming seaweed for prolonged periods.

Page, H.M., Dugan, J.E., Culver, C.S., and Hoesterey, J.C. **Exotic invertebrate species on offshore oil platforms.** *Marine Ecology Progress Series* 325: 101-107, 2006.

Notes: We report the presence of 3 exotic invertebrate species inhabiting offshore oil and gas platforms on the Pacific offshore continental shelf (POCS) of central and southern California, USA. These exotic species occur in high cover or density and may negatively affect populations of native species on the platforms. Conspicuous exotic species (the bryozoan *Watersipora* ?*subtorquata* and the anemone *Diadumene* sp.) were detected on 2 of 7 platforms surveyed. An inconspicuous exotic species (the amphipod *Caprella mutica*) was detected on 2 of 2 platforms surveyed for such smaller species. In addition to serving as a potential source of exotic species to natural reef habitats, the presence of exotic species on oil platforms may influence the degree to which these structures provide the ecological services of natural reefs. The presence of exotic species on platforms also has consequences for various platform decommissioning options in California and elsewhere (there are an estimated 7000 offshore platforms/installations worldwide), including the removal and transport of platforms for use as artificial reefs, if removals are conducted without regard for the potential transport/ dispersal of these species. Further knowledge of the identity of exotic species on oil platforms, their potential for dispersal and interaction with native species, and whether these species can also occur on artificial reefs, will improve our understanding of the effects that artificial structures in general have on the ecological functioning of coastal ecosystems.

Bishop, M.J., Carnegie, R.B., Stokes, N.A., Peterson, C.H., and Burreson, E.M. **Complications of a non-native oyster introduction: facilitation of a local parasite.** *Marine Ecology Progress Series* 325: 145-152, 2006.

Notes: Among the risks of introducing non-native species to novel environments is the possibility that the non-native might serve as a reservoir for enzootic pathogens formerly at low abundance. The recent identification of *Bonamia* sp. in previously uninfected non-native Suminoe oysters deployed to Bogue Sound, Morehead City, North Carolina, USA, raises serious concerns about the oyster's ability to act as a reservoir for the parasite, not formerly known along the east coast of the USA. To assess the current distribution of the *Bonamia* sp. parasite and its environmental tolerances, non-reproductive triploid Suminoe oysters, certified as uninfected, were deployed at 5 high salinity sites across North Carolina, chosen because of their similarity to the Bogue Sound site, and along a salinity gradient radiating from Morehead City Port, at which the parasite is known to occur. Screening of 2 oyster cohorts failed to detect the *Bonamia* sp. parasite beyond the immediate vicinity of Morehead City port. At the port, infection was almost entirely confined to small (< 40 mm shell height) oysters. These results suggest that the parasite, which is genetically similar to Australasian species, is a recent ballast water introduction through Morehead City Port and that its spread may be dependent on the availability of suitable hosts in high salinity environments. Clearly, the proposed introduction of the Suminoe oyster to the mid-Atlantic coast of the USA represents considerable economic and ecological risk and should not proceed without further study to obtain better estimates of likely effects.

Kerckhof, F., Vink, R.J., Nieweg, D.C., and Post, J.N.J. **The veined whelk *Rapana venosa* has reached the North Sea.** *Aquatic Invasions* 1(1): 35-37, 2006.

Notes: An invasive gastropod, the veined whelk *Rapana venosa*, was first recorded in July 2005 in the Dutch part of the North Sea, and in September 2005 in the central southern North Sea (the wider Thames estuary). Both shipping activities and natural dispersion from the nearest population in France (Quiberon, Brittany) are possible modes of introduction of *R. venosa* to these sites. The possible effects of *R. venosa* in the North Sea remain uncertain, but if established, this invasive species could become a severe competitor for the native whelk *Buccinum undatum*. As *R. venosa* is known as predator on bivalves, an impact on local aquaculture activities (on e.g. blue mussels and oysters) is also possible.

Ruiz, G.M., Fegley, L., Fofonoff, P., Cheng, Y., and Lemaitre, R. **First records of *Eriocheir sinensis* H. Milne Edwards, 1853 (Crustacea: Brachyura: Varunidae) for Chesapeake Bay and the mid-Atlantic coast of North America.** *Aquatic Invasions* 1(3): 137-142, 2006.

Notes: We report here the first Chinese mitten crabs, *Eriocheir sinensis* H. Milne Edwards, 1853, found in the Chesapeake Bay, USA. Two male specimens were caught, retained, and identified from the mouth of the Patapsco River, near Baltimore, Maryland. The first crab to be reported was captured on 9 June 2006. Surprisingly, the second reported crab was captured at least one year earlier, probably in May 2005. Another two specimens of *E. sinensis* were reported up to 90km south of this location in April-June 2006, but the identity of these latter crabs could not be confirmed, because the specimens were not kept. Environmental conditions in Chesapeake Bay appear suitable for colonization by *E. sinensis*, and it is presently not known whether mitten crabs are reproducing or established in the region.

Javidpour, J., Sommer, U., and Shiganova, T. **First record of *Mnemiopsis leidyi* A. Agassiz 1865 in the Baltic Sea.** *Aquatic Invasions* 1(4): 299-302, 2006.

Notes: The invasive ctenophore *Mnemiopsis leidyi* was first recorded in the Kiel Bight (western Baltic Sea) on 17 October 2006 during a regular weekly sampling program. The *M. leidyi* abundance gradually increased from 29.5 ± 12.7 ind.m⁻³ in mid-October to 92.3 ± 22.4 ind.m⁻³ in late November 2006. The occurrence of *M. leidyi* in the Baltic Sea is of great concern as this invader has caused negative impacts in the southern seas of Europe.

Hansson, H.G. **Ctenophores of the Baltic and adjacent Seas - the invader *Mnemiopsis* is here!** *Aquatic Invasions* 1(4): 295-298, 2006.

Notes: The invasive ctenophore *Mnemiopsis leidyi* has been detected during late summer and autumn 2006 in northern Europe. So far it has been found in the southern North Sea area, along the Swedish west coast, in the southwestern Baltic and along the south and southwestern Norwegian coasts. From the large populations observed, it is obvious that it must have been introduced before 2006, but remained unrecorded until this autumn.

Bilecenoglu, M., Kaya, M., and Akalin, S. **Range expansion of silverstripe blaasop, *Lagocephalus sceleratus* (Gmelin, 1789), to the northern Aegean Sea.** *Aquatic Invasions* 1(4): 289-291, 2006.

Notes: Following the recent occurrence of *Lagocephalus sceleratus* (Gmelin, 1789) in the Mediterranean Sea, our findings reveal that the species is now very common along the Levant coasts of Turkey. A specimen was recently captured in Izmir Bay (Aegean Sea), representing its north-westernmost occurrence in the Mediterranean. The species has a potential risk to humans, since it contains tetrodotoxin (TTX) that may be a source for food poisoning.

Özcan, T., Galil, B.S., Bakýr, K., and Katađan, T. **The first record of the banana prawn *Fenneropenaeus merguensis* (De Man, 1888) (Crustacea: Decapoda: Penaeidae) from the Mediterranean Sea.** *Aquatic Invasions* 1(4): 286-288, 2006.

Notes: A bilaterally ablated female banana prawn, *Fenneropenaeus merguensis*, collected in the Bay of Iskenderun, southeastern Turkey on 6 October 2006, is likely an escape or an inadvertent release from an aquaculture facility. Because of the high permeability of aquaculture facilities, all introductions should be administered as to avoid unintentional releases or escapes into the wild.

Faasse, M.A. and Bayha, K.M. **The ctenophore *Mnemiopsis leidyi* A. Agassiz 1865 in coastal waters of the Netherlands: an unrecognized invasion?** *Aquatic Invasions* 1(4): 270-277, 2006.

Notes: The introduction of the American ctenophore *Mnemiopsis leidyi* to the Black Sea was one of the most dramatic of all marine bioinvasions and, in combination with eutrophication and overfishing, resulted in a total reorganization of the pelagic food web and significant economic losses. Given the impacts this animal has exhibited in its invaded habitats, the spread of this ctenophore to additional regions has been a topic of much consternation. Here, we show the presence of this invader in estuaries along the Netherlands coast, based both on morphological observation and molecular evidence (nuclear internal transcribed spacer region 1 [ITS-1] sequence). Furthermore, we suggest the possibility that this ctenophore may have been present in Dutch waters for several years, having been misidentified as the morphologically similar *Bolinopsis infundibulum*. Given the level of shipping activity in nearby ports (e.g. Antwerp and Rotterdam), we find it likely that *M. leidyi* found its way to the Dutch coast in the ballast water of cargo ships, as is thought for *Mnemiopsis* in the Black and Caspian Seas. Given the magnitudes of the impacts this ctenophore has shown in its native and introduced ranges, the animal's potential effects on the North Sea pelagic ecosystem and fisheries warrant close observation in the coming years. The development of large ctenophore aggregations during recent years was probably driven by the higher than average sea surface temperatures in the North Sea, and we hypothesize that populations from the southern North Sea may have been the source of the invaders reported in the Baltic Sea and the Skagerrak. If these northern populations (Baltic, etc.) are not able to over-winter, it is possible that established populations in southern North Sea estuaries may serve as a yearly supply of invaders to the colder waters to the north.

Gollasch, S. and Nehring, S. **National checklist for aquatic alien species in Germany.** *Aquatic Invasions* 1(4): 245-269, 2006.

Notes: More than 140 aquatic alien species (AAS) have been reported from coastlines of the North Sea and the Baltic Sea and from inland waters within the national borders of Germany. The majority of these species has established self-sustaining

populations. The most important vectors of introduction are shipping, species imports for aquaculture purposes and species imports as part of the ornamental trade. Several AAS have reached German waters via shipping canals. Many species show a locally limited distribution, but almost half of all AAS have spread successfully across larger areas. Several introduced species are abundant and approximately 20 % of all AAS in Germany can be considered as invasive. Prime source regions are the north-western Atlantic, the Indo-Pacific, and the Ponto-Caspian region. For all source regions considered, the invasion rate has been increasing since the end of the last century.

Ashton, G., Boos, K., Shucksmith, R., and Cook, E. **Risk assessment of hull fouling as a vector for marine non-natives in Scotland.** *Aquatic Invasions* 1(4): 214-218, 2006.

Notes: To determine the importance of recreational boating as a vector for distributing marine organisms, including non-native species, the extent of hull fouling species on recreational yachts in Scotland was assessed. In August 2006, up to 100 yachts in each of the ten largest marinas in Scotland were ranked using a fouling index. 23 yacht owners were asked a questionnaire to determine the importance of general characteristics of the yacht and its travel history in relation to the level of hull fouling. 59 % of the yachts surveyed were found to have macrofouling attached to their hulls, suggesting that recreational boating has a high potential for distributing marine species throughout Scotland. Increased age of the antifouling paint, as well as long stationary periods and reduced sailing activity increase the risk of macrofouling species attaching to hulls. Recreational boating must be considered as a high risk vector for non-native species in Scotland.

Ashton, G., Boos, K., Shucksmith, R., and Cook, E. **Rapid assessment of the distribution of marine non-native species in marinas in Scotland.** *Aquatic Invasions* 1(4): 209-213, 2006.

Notes: In August 2006, the ten largest marinas in Scotland were surveyed for the presence of seven non-native species, known to occur at other locations within the UK: the crustaceans *Caprella mutica* and *Eriocheir sinensis*, ascidians *Perophora japonica* and *Styela clava*, the green alga *Codium fragile* subsp. *tomentosoides*, and brown algae *Sargassum muticum* and *Undaria pinnatifida*. A variety of structures, including pontoon floats, chains and harbour walls were inspected to a depth of 0.5 m for the presence of these non-native species. Seven of the marinas had one or more of the target species. *C. mutica* was found at seven marinas; *C. fragile* subsp. *tomentosoides* at two marinas; *S. muticum* and *S. clava* were each found at a single marina; *E. sinensis*, *P. japonica* and *U. pinnatifida* were not found. The survey suggests that recreational boating is an important vector for the dispersal of marine non-native species, and that marinas may act as a refuge for such species. Further and regular port surveys throughout the UK are recommended to provide an effective early warning system for invasive non-native species.
