Tamar Estuaries

MARINE BIOSECURITY PLAN

NON-NATIVE SPECIES GUIDE (V2)

2023

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TAMAR ESTUARIES CONSULTATIVE FORUM
OUR COMMON ASSET

Non-native species

Due to its long history as a naval and commercial port and its proximity to the coast of mainland Europe, the Tamar Estuaries area is somewhat of a hot-spot for non-native species (NNS). Table 1 lists 19 NNS that have a significant presence in the area, more information about these species, including their likely impacts[1], is provided in the next section. A further 35 NNS, known to occur in the area, are listed in Appendix 1. There are also some small planktonic species that are not listed. A number of other species already present in the UK or N Europe that are highly likely to spread to the area imminently are described in a later section. More information can be found on the GB NNSS information portal[2].

Table 1: Non-native species present – top 19

	Species	Common name	UK priority monitoring list	Occurrence habitats	
				Artificial	Natural
SEA SQUIRTS	*Aplidium* cf. *glabrum*	(a colonial sea squirt)		✓✓	✓
	Asterocarpa humilis	Compass sea squirt	✓	✓new 2011	✓new 2014
	Botrylloides diegensis	San Diego sea squirt		✓	elsewhere UK
	Botrylloides violaceus	Orange cloak sea squirt		✓✓✓	✓
	Corella eumyota	Orange-tipped sea squirt	✓	✓	✓
	Didemnum vexillum	Carpet sea squirt	✓	✓	elsewhere UK
	Styela clava	Leathery sea squirt	✓	✓✓	✓
BRYOZOANS	*Bugula neritina*	Ruby bryozoan		✓✓✓	✓new 2018
	Schizoporella japonica	Orange ripple bryozoan	✓	✓new 2012	elsewhere UK
	Tricellaria inopinata	Tufty-buff bryozoan		✓✓✓	✓✓
	Watersipora subatra	Red ripple bryozoan	✓	✓✓✓	✓✓new 2015
MOLLUSCS	*Crepidula fornicata*	Slipper limpet	✓	✓	✓✓✓
	Magallana gigas	Pacific oyster	✓	✓✓✓	✓✓✓
BARNACLES	*Austrominius modestus*	Bay barnacle		✓✓	✓✓
WORMS	*Bispira polyomma*	Purple fan-worm		✓new 2021	
ALGAE	*Undaria pinnatifida*	Wakame	✓	✓✓✓	✓✓
	Sargassum muticum	Wireweed	✓	✓	✓✓✓
	Grateloupia turuturu	Devil's tongue weed	✓	✓✓✓new 2012	✓✓new 2012
	Caulacanthus okamurae	Pom-pom weed	✓	✓new 2014	✓✓✓new 2014

Note: Occurrences: ✓ = Rare/Occasional ✓✓ = Frequent/Common ✓✓✓ = Abundant/Superabundant

Species descriptions

The environmental and socio-economic risk scores given for each species below are based on information in the GB NNSS risk assessments[3] for species where completed, risk assessments carried out by Cefas, and on the experience of the impacts of these species in other parts of the UK and in the Tamar Estuaries area to date.

[1] Macleod, A., Cook, E. J., Hughes, D., & Allen, C. (2016). *Investigating the Impacts of Marine Invasive Non-Native Species*. A report by Scottish Association for Marine Science Research Services Ltd for Natural England & Natural Resources Wales, pp. 59. Natural England Commissioned Reports, Number 223.
[2] GB NNSS Information Portal - www.nonnativespecies.org/non-native-species/information-portal/
[3] GB NNSS Risk Assessments - www.nonnativespecies.org/non-native-species/risk-analysis/risk-assessment/

Pacific oyster (Magallana *gigas*)

Environmental risk HIGH **Economic risk HIGH**

Native to Japan and SE Asia, Pacific oysters were deliberately introduced to the UK in the 1960s for commercial purposes with the first record from the wild being in 1965. Farmed populations occur throughout the UK and Europe. It was initially presumed that temperatures in British waters would not be suitable for them to successfully reproduce, but escapees have established feral populations in SE and SW England and Wales. There are extensive beds of naturally recruited Pacific oysters in some southern estuaries of England including the Tamar, where it is considered a risk to the ecological status of the SAC[4]. *M. gigas* is an ecosystem engineering species, altering habitats and ecosystems through reef formation; this can displace native oysters and have a negative impact on native biodiversity. Economically, although wild populations may be exploited by local fishermen, they can foul artificial structures and make shores unattractive to leisure users because of the sharpness of the shells underfoot.[5]. Natural England has developed guidance for voluntary groups on the manual removal of Pacific oysters.

Fig. 1: *Magallana gigas*. Image © J. Bishop

Slipper limpet (*Crepidula fornicata*)

Environmental risk HIGH **Economic risk HIGH**

The slipper limpet arrived in S England in the late 19th Century and is now well established on the southern coasts of England and Wales and spreading northward. It can smother seabed species, alter seabed habitat structure dramatically and compete for food and space with other filter-feeding species including mussels and oysters. It is also likely to consume the planktonic larvae of some species. *C. fornicata* has been known to foul a variety of hard-shelled commercially important and farmed species such as oysters, and man-made structures and equipment. It is possible to mechanically remove slipper limpets from the seabed; however, tests have shown this to be costly and extremely destructive. In the Tamar Estuaries area it is having a negative impact on the condition of the Plymouth Sound and Estuaries SAC subtidal mixed sediments and mud[6].

Fig. 2: *Crepidula fornicata*, Plymouth. Image © J. Bishop

Carpet sea squirt (*Didemnum vexillum*)

Environmental risk HIGH **Economic risk HIGH**

Carpet sea squirt was first recorded in 2008 in Holyhead and has now been recorded at a number of locations in the UK. In the Tamar Estuaries area small colonies have occasionally been found in two Plymouth marinas, these colonies are removed but they often re-appear, although it doesn't seem to be spreading. It is present in greater abundance nearby in the river Dart. It forms pale orange, cream or off-white colonies of extensive thin (2-5 mm) sheets and can form long pendulous outgrowths. Colonies can rapidly overgrow other fauna and occupy a substantial proportion of available space. On

Fig. 3: *Didemnum vexillum.* Image © J. Bishop

[4] SIP174 Site Improvement Plan – Plymouth Sound and Tamar Estuary available at: http://publications.naturalengland.org.uk/publication/6283453993582592

[5] Herbert, R. J., Humphreys, J., Davies, C. J., Roberts, C., Fletcher, S., & Crowe, T. P. (2016). Ecological impacts of non-native Pacific oysters (*Crassostrea gigas*) and management measures for protected areas in Europe. Biodiversity and Conservation, 25(14), 2835-2865.

[6] Natural England Condition Assessment – Plymouth Sound and Estuaries Special Area of Conservation (2016).

offshore banks in the US it has shown very extensive coverage of the seabed, potentially smothering species living in gravel and affecting aquaculture of species such as mussels and oysters. An indication that this is also happening in the UK can be seen in a Seasearch video from Herne Bay off the Kent coast[7].There have been decreases in brittle stars and sea urchins noted in The Netherlands. Eradication has been tried by wrapping affected surfaces in polythene sheets secured with cable ties. This has been effective, although extremely costly, in New Zealand and to some extent in N Wales, causing the encased sea squirt to suffocate and decay within days; this can be enhanced by adding a biocide such as bleach within the plastic wrapping. Repopulation from an unknown source has occurred in N Wales.

Orange-tipped sea squirt (*Corella eumyota*)

Environmental risk MEDIUM Economic risk MEDIUM

The orange-tipped sea squirt is native to the S hemisphere and was probably introduced here via aquaculture. It spread rapidly around the UK after its discovery on the S coast in 2004. It is a solitary sea squirt, 2-4 cm long, which often attaches to hard substrates such as cobbles, boulders, ship hulls and shells of mussels and oysters. It may threaten oyster and mussel farms through fouled gear and by smothering and outcompeting cultures. Individuals are self-fertile so it can quickly establish and may form dense clumps. Until recently, it was abundant in marinas and on natural shores in the Tamar Estuaries area. However, it has become much rarer in the area over the last few years.

Fig. 4: *Corella eumyota,* Noss Mayo. Image © J. Bishop

Orange cloak sea squirt (*Botrylloides violaceus*)

Environmental risk MEDIUM Economic risk MEDIUM

Native to Japan, this colonial sea squirt forms firm gelatinous sheets or cushions up to 15 cm across and each colony has a single colour: bright orange, violet, brick red, pink or yellow. It is well established in harbours and marinas throughout the UK. It is present at high densities in some Plymouth marinas and is now regularly being found in local natural habitats. Colonies can overgrow other fauna and occupy substantial space. There is some evidence of displacement of native species. Back-to-back growth can produce fist-sized three-dimensional masses likely to render submerged gear cumbersome. Colonies can also block inlet pipes on boats. Where well established, mechanical clearance (and disposal) or blanket biocide treatment would be required to ensure eradication.

Fig. 5: *Botrylloides violaceus*, Plymouth. Image © J. Bishop

San Diego sea squirt (*Botrylloides diegensis*)

Environmental risk MEDIUM Economic risk MEDIUM

Also native to Japan, this sea squirt is very similar in form to *B. violaceus.* The colonies can be a single colour (commonly orange) thereby closely resembling *B. violaceus*, or each inhalant orifice can be surrounded by a drop-shaped patch of solid orange, white or yellow, which contrasts strongly with the darker background, resulting in some very distinctive colour patterns. Although it is well established in harbours and marinas elsewhere the UK, it is currently present at much lower densities in Plymouth marinas than *B. violaceus*, and it has not yet been recorded from local shores. Impact and management are the same as for *B. violaceus*.

Fig. 6: *Botrylloides diegensis.* Image © J. Bishop

[7] Video of *D. vexillum* off Herne Bay www.youtube.com/watch?v=eHrwWFaUF4Y

Wakame (*Undaria pinnatifida*)

Environmental risk MEDIUM Economic risk MEDIUM

Wakame is a brown kelp native to the NW Pacific. It is very fast growing with fronds reaching 1-3 m, the blade has a distinct midrib and, when reproductive the stipe has a characteristic frill. *U. pinnatifida* is tolerant of a wide range of temperatures and salinities and grows well in estuarine conditions. It is particularly prevalent along the S coast of England. It is abundant in most Plymouth marinas and has been identified as a risk to the ecological status of the SAC being well established along intertidal and subtidal rocky substrata throughout Plymouth Sound[8]. It competes for space with native kelp species and may be a nuisance fouling jetties, vessels, moorings and buoys; it has the potential to impact on aquaculture through fouling. Heavy infestations may also clog machinery and restrict water circulation. More information can be found on the Wakame Watch website[9].

Fig. 7: *Undaria pinnatifida*, Plymouth. Image © J. Bishop

Wireweed (*Sargassum muticum*)

Environmental risk MEDIUM Economic risk MEDIUM

Wireweed is a distinctive large olive-brown seaweed originating from Japan; it is believed that it was introduced to the UK with imports of Pacific oysters. It is often over 1m long and its lateral branches hang like washing from a line when held out of the water. It is distributed widely around the UK. Wireweed competes with native seaweeds and sea grasses through rapid-growth, shading and abrasion. It can be a nuisance in harbours and shallow waters where it is a hazard to boating due to entanglement of propellers, however in the Tamar estuaries area it is rarely found in marinas. It can dominate in rock pools e.g. at Wembury, altering the habitat and it is considered a risk to the ecological status of the Special Area of Conservation (SAC). There is some concern over potential fouling of aquaculture installations. Whilst physical removal may be possible, care must be taken to prevent further spread of the species, and re-colonisation from surrounding populations following clearance is likely.

Fig. 8: *Sargassum muticum*, Mt Edgcumbe. Image © J. Bishop

Pom-pom weed (Caulacanthus okamurae)

Environmental risk MEDIUM Economic risk LOW

Pom-pom weed is a small red seaweed forming dense springy tangled clumps. Native to Asia it was first recorded in the UK in 2004 on the S coast. It has distinctive short incurved thorn-like forked side branches. It is very common on the mid and low shore in the Tamar Estuaries area. Turf formation can alter the habitat, displacing macro-invertebrates, such as barnacles.

Fig. 9: *Caulacanthus okamurae*, Jupiter Point. Image © C. Wood

[8] De Leij, R., Epstein, G., Brown, M. P., & Smale, D. A. (2017). The influence of native macroalgal canopies on the distribution and abundance of the non-native kelp *Undaria pinnatifida* in natural reef habitats. *Marine Biology*, *164*, 1-15.

[9] http://wakamewatch.org.uk/

Devil's tongue weed (*Grateloupia turuturu*)

Environmental risk MEDIUM Economic risk LOW

Devil's tongue weed is a large red alga from the NW Pacific, with broad slippery blades and a very small holdfast. Although it has been present in the UK since 1969, in recent years it seems to be spreading more aggressively. It is common in Plymouth marinas and is regularly found locally on the natural shore. It is believed to have been introduced through shellfish imports. It grows on artificial and natural hard substrata, including rock pools, shells and stones. It is tolerant of variable temperature and salinity regimes. *G. turuturu's* large size and high reproductive output means it can out-compete many native macroalgae in the low intertidal and shallow subtidal zones; it can also alter trophic patterns and cause habitat loss through shading.

Fig. 10: *Grateloupia turturu*. Image © C. Wood

Purple-fan worm (Bispira polyomma)

Environmental risk MEDIUM Economic risk LOW

Fig. 11: *Bispira polyomma*, Plymouth. Image © J. Bishop

The purple-fan worm was discovered in the Netherlands in 2010 and described as new to science, but regarded as a non-native introduction there. It has a short, soft mud tube and a tentacle crown that is blue or purple in bright light. It was first reported in the UK in 2021 in two adjacent marinas in Plymouth, sometimes forming dense patches[10]. It has subsequently been found in several UK marinas/harbours, suggesting that it may have been overlooked for some time. There is very little information regarding its habitat preferences, or likely impacts, although it seems to have the potential to be a significant fouling species.

Tufty-buff bryozoan (*Tricellaria inopinata*)

Environmental risk MEDIUM Economic risk LOW

The tufty-buff bryozoan is an opportunistic erect bryozoan, capable of enduring a wide range of temperatures and salinities, as well as high organic content. It settles on a wide range of anthropogenic and natural surfaces. It was observed in Poole Harbour in 1998 and by 2009 was present in Scotland. It is a fast growing fouling organism, settling on buoys, vessels and ropes. During surveys of yachts in a Plymouth marina it was found on 85% of hulls, often as an inconspicuous fringe along the keel, prop and propeller. It is now regularly being found in natural habitats in the Tamar Estuaries area. The invasion of this species in the Venice Lagoon in the 1980s appears to have caused a drastic reduction in native bryozoan species.

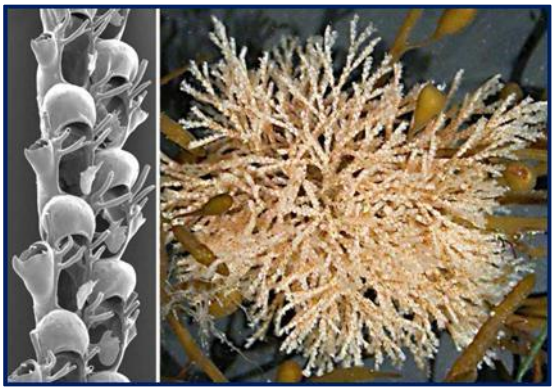

Fig. 12: *Tricellaria inopinata*, Plymouth. Image © J. Bishop and A. Yunnie

[10] Bishop, J. D. D., & Darbyshire, T. (2023). The first UK records of the purple fan-worm, *Bispira polyomma* Giangrande & Faasse, 2012 (Annelida: Sabellidae). *BioInvasions Records*, *12*(1), 186-195.

Red ripple bryozoan (*Watersipora subatra)*

Environmental risk MEDIUM Economic risk LOW

Fig. 13: *Watersipora subatra*, Plymouth. Image © J. Bishop

The red ripple bryozoan is a S hemisphere species which successfully invaded ports throughout the world. It was first recorded in Plymouth in 2008, initially spreading rapidly along the S coast. It was recently recorded as far north as Suffolk and Anglesey. *Watersipora subatra* forms bright red-orange-black rigid, encrusting colonies that grow on rocks, shells (particularly mussels), kelp holdfasts, other bryozoans, boat hulls, and in marinas. The circular colonies can grow quite large and expand outward from the surface, creating lobes and frills. The most likely initial vectors of spread for *W. subatra* was the importation of shellfish for aquaculture and hull fouling. Recreational boats are a potential vector of spread around the UK. Additionally, *W. subatra* is copper tolerant so is unaffected by many anti-fouling treatments. In the Tamar Estuaries area until 2016, this species was an inconspicuous presence in the fouling community in marinas. However, in 2016, its abundance in marinas rose markedly and it is becoming increasingly prevalent on rocky shores, especially under overhangs and on vertical faces.

Orange ripple bryozoan (*Schizoporella japonica)*

Environmental risk MEDIUM Economic risk LOW

Fig. 14: *Schizoporella japonica*. Image © C. Wood

The orange ripple bryozoan, originally from Japan, was first detected in the UK in Holyhead, Wales, in 2010 and then in N Scotland in 2011 and Plymouth in 2012 (although an earlier single occurrence in Plymouth from 2009 has now been discovered). It is now widespread throughout some areas of Scotland including in natural habitats. It is a small, colonial animal that forms orange encrusting mats across rocks, algae, shells and artificial substrates. It forms circular colonies that can grow quite large forming extensive encrustations with lobes and frills. It can reproduce over a wide temperature range, which means it can reproduce in the UK winter, unlike most of its competitors and therefore, competition for resources (e.g. space) is reduced. Likely impacts include fouling of marinas, boat hulls, aquaculture equipment, and mussel and oyster shells, which can lead to increased cleaning costs. Additionally, *S. japonica* can dominate the fouling community and directly compete with native species for space and food. It is known to inhibit the growth of adjacent species. In the Tamar Estuaries area it is has been recorded in three marinas.

Leathery sea squirt (*Styela clava)*

Environmental risk LOW Economic risk MEDIUM

Fig. 15: *Styela clava*. Image © J. Bishop

The leathery sea squirt is a large solitary sea squirt widespread in the UK, indigenous to the NW Pacific and was first recorded in the UK in Plymouth in 1953, possibly introduced on the hulls of war ships returning from the Korean War. It attaches by a small flat holdfast at the base of a narrow stalk, its rough exterior is usually colonised by other fouling species such as other sea squirts and bryozoans, and thus it can increase the available space for settlement for native as well as non-native species. It attaches to solid surfaces in shallow water, especially in harbours and marinas but also on wrecks and natural rock bottoms. It can achieve high densities and did prove to be a severe nuisance to long-line mussel farming in Canada until replaced by other invasive species, however, this species has not been noted as a problem to aquaculture in the UK to date. In the Tamar Estuaries it is common in marinas, but on the shore and sub-tidally, although regularly recorded, it is much rarer.

Compass sea squirt (*Asterocarpa humilis*)

Environmental risk LOW **Economic risk MEDIUM**

The compass sea squirt is a solitary ascidian native to the S Hemisphere. First recorded in the UK in 2009 in SW England it is spreading rapidly around the UK. It is orange-red with a tough outer tunic, can be up to 4 cm across and has distinctive compass-like markings around the siphons. It is a potential fouler of aquaculture equipment, clumps could clog pipes, and is a potential competitor for food and space with cultured bivalves. In the Tamar Estuaries area it is now entering natural habitats.

Fig. 16: *Asterocarpa humilis*, Plymouth. Image © J. Bishop

Aplidium cf. *glabrum*

Environmental risk LOW **Economic risk LOW**

This colonial ascidian is similar in zooidal morphology to the native *Aplidium glabrum*, but is found in warmer waters than are typical of the native species. Its origin and identity are unknown but it is widespread in the UK and throughout Europe. It is a threat to biodiversity and aquaculture through smothering, colonies could block inlet pipes. It is now entering natural habitats in the Tamar Estuaries area.

Fig. 17: *Aplidium* cf. *glabrum*. Image © C. Wood

Ruby bryozoan (*Bugula neritina*)

Environmental risk LOW **Economic risk LOW**

The ruby bryozoan is purple or golden-brown and forms erect, bushy growths up to 8 cm long. It was first recorded in c.1911 but by the late 1990s was thought to be no longer present, a rapid recolonization has since occurred and it is now widespread in the UK. An abundant fouling organism, it colonises a variety of sub-tidal substrata including artificial structures and vessel hulls; it has not yet been recorded from natural habitats locally.

Fig. 18: *Bugula neritina*. Image © J. Bishop

Darwin's barnacle (*Austrominius modestus*)

Environmental risk LOW **Economic risk LOW**

Fig. 19: *Austrominius modestus.* Image © J. Bishop

(Note: future risks are considered low only because this species has already spread to virtually all suitable habitats throughout the UK).

Native to Australasia, Darwin's barnacle has probably been present in the UK since 1946. It attaches to a variety of surfaces including rocks, stones, hard-shelled animals and artificial structures including ships, and tolerates a wider range of salinity and turbidity than native species. This is a fast-growing species that is quick to reach maturity, which, combined with its high reproductive output in water temperatures above 6ºC, gives it a competitive advantage over native species. This barnacle can dominate hard surfaces and displace native species; it has largely displaced native barnacles in estuaries in southwest England, although impacts are less significant on exposed rocky shores. In favourable conditions is can be a nuisance as a fouling organism.

Horizon scanning – high risk species to look out for

Due to the high levels of maritime traffic including international and cross-channel traffic the Tamar Estuaries area is extremely vulnerable to the arrival of a number of other NNS. Those species that present a particularly high risk of arrival and impact are *Homarus americanus,* the American lobster, *Eriocheir sinensis*, the Chinese Mitten Crab; and *Hemigrapsus spp.*, Asian shore crabs. More information on these species is detailed below. A further 26 potential invaders from other areas of the UK or other parts of the world are listed at Appendix 2.

American lobster (*Homarus americanus*)

Risk of introduction to area HIGH **Environmental risk HIGH** **Economic risk HIGH**

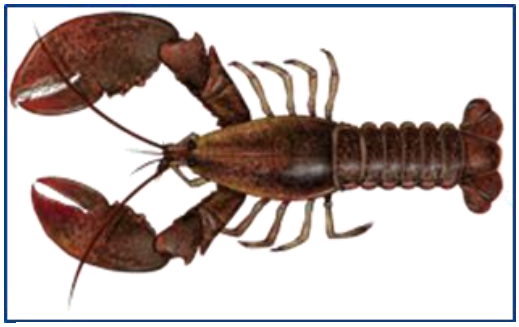

Fig. 20: *Homarus americanus*. Image NOAA FishWatch

American lobsters are native to the E coast of N America and Canada, but have been imported live into Europe for several decades resulting in their escape into the wild. The American lobster was first recorded in the UK in 1988. Since a deliberate mass release in Brighton in 2015, finds have increased. The most recent record from nearby is from Torquay in 2017. American lobsters could have a significant impact on the native European lobster (*Homarus gammarus*) fisheries as they are more aggressive, grow to a larger size, are more fecund, are more adaptive, being found in a broader range of habitat, and are highly mobile. In addition, American lobsters have also been found to breed with European lobsters in the wild resulting in hybridisation. Thus, American lobsters could out-compete European lobsters, and other economically and environmentally important species, such as the brown crab, *Cancer pagurus*, if they were to become established. Threats from American lobsters also include diseases, for example *Gaffkaemia*, a bacterial disease that is lethal to Homarus spp.. For guidance on distinguishing between *H. americanus* and *H. gammarus* see GBNNSIP [11,12,13] the main feature being the presence of spines on the ventral surface of the rostrum.

Chinese mitten crab (*Eriocheir sinensis)*

Risk of introduction to area HIGH **Environmental risk HIGH** **Economic risk HIGH**

Fig. 21: *Eriocheir sinensis*. Image © Huw Jones

First introduced to the Thames Estuary in 1935, the Chinese mitten crab is now established in several sites throughout England and Wales. Juveniles occur in lower estuaries and marine habitats. As they develop, young crabs migrate upstream, into freshwater and brackish systems. Adults usually live in burrows in muddy riverbanks, although aquatic vegetation and marshes may provide an alternative habitat. Adults migrate into deep, open, saltwater locations to reproduce. This species can impact marine and freshwater ecosystems and is a voracious predator that will consume a range of invertebrate species and the eggs of fish leading to competition with native species and impacting invertebrate and fish populations. It burrows into river banks, increasing erosion and river turbidity, and causing bank collapse. Burrowing also leads to the siltation of gravel beds, including those used for fish spawning. Now that the Chinese mitten crab has arrived in the UK, it can be expected to spread through natural dispersal; however, intervention may be possible to prevent new populations becoming established in un-infested rivers such as the Tamar. No methods of mechanical management are known. More information can be found on the Mitten Crab website[14].

[11] *H. americanus* factsheet www.nonnativespecies.org/non-native-species/information-portal/view/1736
[12] www.nonnativespecies.org/assets/Uploads/ID_Homarus_americanus_American_lobster_final_1214-1.pdf
[13] www.nonnativespecies.org/assets/Document-repository/A3_Cefas_Lobster_poster_QRCode_13-1-20_final-2.pdf
[14] http://mittencrabs.org.uk

Asian shore crabs (*Hemigrapsus sanguineus* and *H. takanoi*)

Risk of introduction to area HIGH **Environmental risk HIGH** **Economic risk MEDIUM**

Fig. 22: *Hemigrapsus takanoi*. Image © J. Bishop

Native to the NW Pacific, both species of Asian shore crab were first identified in the UK in 2014 (although it is now known that *H. takanoi* was already present in 2013). They are small squarish-shaped crabs with three 'teeth' on either side of well-spaced eyes. *H. sanguineus* has clearly banded legs and purple-red spots on its claws, whereas the upper-side of *H. takanoi* has small brown spots. They occur on muddy and rocky shores and in sheltered estuaries and port areas, they have also been found in oyster reefs. In the UK, there have only been a few sitings *of H. sanguineus*, but *H. takanoi* is now common on shores in E. Anglia and Kent. They are abundant on some shores on the NW coast of Europe and there is a high risk of further arrivals and spread through ballast water, hull fouling and larval dispersal (larvae can survive up to 55 days in water column). They can out-compete the native shore crab *Carcinus maenas* and could have a negative impact on prey species such as juvenile mussels and oysters so potentially affecting spat supply in shellfish farms.

Appendix 1 - Further NNS known from the area

	Species	Common name	UK priority monitoring list	Occurrence habitats	
				Artificial	Natural
FISH	*Oncorhynchus gorbuscha*	Pacific pink salmon			✓new 2021
SEA SQUIRTS	*Botrylloides diegensis*	San Diego sea squirt		✓new 2014	elsewhere UK
	Ciona robusta	Vase tunicate		✓	elsewhere UK
	Perophora japonica	Creeping sea squirt		✓✓	✓new 2020
BRYOZOANS	*Bugulina simplex*	(an erect bryozoan)		✓	elsewhere UK
	Bugulina stolonifera	(an erect bryozoan)		✓	✓new 2018
	Bugulina fulva	(an erect bryozoan)		✓✓	elsewhere UK
MOLLUSCS	*Mya arenaria*	Soft-shell clam			✓
	Ruditapes philippinarum	Manila clam			✓
	Urosalpinx cinerea	American oyster drill	✓		✓last 1998
BARNACLES	*Amphibalanus amphitrite*	Striped barnacle	✓	last 2011	elsewhere UK
	Amphibalanus cirratus	(an acorn barnacle)		✓new 2023	
	Amphibalanus improvisus	Bay barnacle		✓	✓✓
	Solidobalanus fallax	Rosy hitcher barnacle	✓	✓last 2011	✓
ANEMONES & HYDROIDS	*Cordylophora caspia*	(a freshwater hydroid)		elsewhere UK	✓
	Diadumene lineata	Orange-striped anemone	✓	✓	elsewhere UK
WORMS	*Ficopomatus enigmaticus*	Trumpet tube worm	✓	✓	✓
	Goniadella gracilis	(a polychaete worm)			✓
	Hydroides elegans	(a serpulid worm)			✓new 2016
	Hydroides ezoensis	Twin-keel worm		elsewhere UK	✓new 2021
	Sternaspis scutata	(a bristleworm)		✓	✓
CRUSTACEA	*Acartia (Acanthacartia) tonsa*	(a copepod)	✓		✓last 1996
	Caprella mutica	Japanese skeleton shrimp	✓	✓	elsewhere UK
	Monocorophium sextonae	(an amphipod)			✓✓
	Penaeus japonicus	Kuruma prawn			✓last 2004
ALGAE	*Antithamnionella spirographidis*	(a red seaweed)		elsewhere UK	✓last 1986
	Antithamnionella ternifolia	(a red seaweed)		elsewhere UK	✓new 2021
	Asparagopsis armata	Harpoon weed	✓	elsewhere UK	✓✓
	Bonnemaisonia hamifera	Hook weed	✓		✓✓
	Codium fragile fragile	Green sea fingers		✓	✓
	Colpomenia peregrina	Oyster thief		✓	✓✓
	Cryptonemia hibernica	(a red seaweed)			✓last 2003
	Dasysiphonia japonica	Siphoned Japan weed		✓last 2018	✓new 2019
	Melanothamnus harveyi	Harvey's siphon weed		✓new 2018	✓
PLANTS	*Spartina townsendii* var. *anglica*	Common cord-grass			✓✓

Note: Occurrences: ✓ = Rare/Occasional ✓✓ = Frequent/Common ✓✓✓ = Abundant/Superabundant

Appendix 2 – Further Horizon Scan species

Listed below are examples of species that could spread to the Tamar Estuaries area from other parts of the UK, Europe or other regions of the world. It is not a definitive list; there are many other potential invaders. This list was derived mainly from a study of current species distributions in the UK, and a GB horizon scanning exercise carried out in 2019[15].

Species	Common name	In UK	In Europe	UK priority monitoring /surveillance list
Ammothea hilgendorfi	Japanese sea spider	Y	Y	
Arcuatula senhousia	Asian date mussel	Y	Y	M
Botryocladia wrightii	Golden membrane weed	Y	Y	M
Callinectes sapidus	American blue crab	Y	Y	
Cephalothrix simula	Pacific death worm	Y	Y	M
Ensis leei	American jackknife clam	Y	Y	M
Gracilaria vermiculophylla	Worm wart weed	Y	Y	M
Mnemiopsis leidyi	American comb jelly	Y	Y	M
Mulinia lateralis	Dwarf surf clam	Y	Y	S
Rapana venosa	Veined rapa whelk	Y	Y	S
Rhithropanopeus harrisi	Harris mud crab	Y	Y	
Pterois miles/volitans	Lionfish	Y	Y	
Umbraulva dangeardii	(a green seaweed)	Y	Y	
Ciona savignyi	(a sea squirt)	N	Y	S
Celtodoryx ciocalyptoides	Cauliflower sponge	N	Y	S
Dyspanopeus sayi	Say mud crab	N	Y	S
Megabalanus coccopoma	Titan acorn barnacle	N	Y	S
Megabalanus tintinnabulum	Giant purple barnacle	N	Y	S
Mytilicola orientalis	(a parasitic copepod)	N	Y	
Ocinebrellus inornatus	Japanese oyster drill	N	Y	S
Potamocorbula amurensis	American river clam	N	Y	
Rugulopteryx okamurae	Asian fan weed	N	Y	
Styela plicata	Pleated sea squirt	N	Y	
Xenostrobus securis	Black pygmy mussel	N	Y	
Asteria amurensis	Northern Pacific seastar	N	N	S
Geukensia demissa	Ribbed mussel	N	N	

[15] www.nonnativespecies.org/non-native-species/risk-analysis/horizonscanning/