NOBANIS – Invasive Alien Species Fact Sheet

Callinectes sapidus

Author of this species fact sheet: Stefan Nehring, Federal Agency for Nature Conservation, Konstantinstraße 110, 53179 Bonn, Germany, Phone: +49 228 8491 1444, E-Mail: Stefan.Nehring[at]bfn.de, http://www.bfn.de

Bibliographical reference – how to cite this fact sheet:
Nehring, S. (2012): NOBANIS – Invasive Alien Species Fact Sheet – ***Callinectes sapidus***. – From: Online Database of the European Network on Invasive Alien Species - NOBANIS www.nobanis.org, Date of access x/x/201x.

Species description

Scientific names: *Callinectes sapidus* Rathbun 1896, Portunidae, Decapoda
Synonyms: *Callinectes hastatus* Ordway 1883; *Lupa diacantha* Milne-Edwards 1834; *Lupa hastata* Say 1817; *Portunus diacantha* Latreille 1825.
Common names: blue crab (GB), blauwe zwemkrab (BE), Blaukrabbe (DE), blå krabbe, blå svømmekrabbe (DK), tavaline sinikrabi (EE), Sinitaskurapu (FI), blauwe zwemkrab (NL), blåkrabbe, blå svømmekrabbe (NO), sinii kzab (RU), blåkrabba (SE)

Fig. 1 and 2. Mature female of *Callinectes sapidus* caught in German Weser estuary on 20th of July 2007. Half-dorsal view, with typical red-tipped claws, and ventral view, with typical bell-shaped apron; photos by Jörg Albersmeyer.

Species identification

Callinectes sapidus is a decapod crustacean of the family Portunidae, which includes the swimming crabs. The carapace is wider than long (more than twice including the antero-lateral spines). It is easily identified by its body color which is generally a bright blue along the frontal area, especially along the chelipeds. The remainder of the body is shaded an olive brown color. As with other Portunids, the fifth leg is adapted to a paddle-like shape to accommodate swimming. Mature females may be identified due to their triangular or rounded aprons and orange/red fingers tipped with reddish/purple. The carapace of the blue crab can grow to a length of around 9 cm in males and 7.5 cm in females; it is usually about 17 cm wide (maximum around 20 cm), but individuals with a

carapace some 27 cm across have been caught. A blue crab may live up to four years and can reach a body weight of up to 1 kg. *C. sapidus* differs from other *Callinectes* species in number of frontal teeth (two vs. four) and in the length and curvature of the gonopods of mature males.
Key references: Hill *et al.* 1989, Hill 2004, FAISH 2006, Food and Agriculture Organization 2007.

Native range
The natural range of the blue crab covers the Atlantic coast of America from Nova Scotia (Canada) to northern Argentina. It is most abundant from Texas to Massachusetts (Hill *et al.* 1989).

Alien distribution

History of introduction and geographical spread
The first record of *C. sapidus* from Europe was collected in 1900 on the Atlantic coast of France (Bouvier 1901). Subsequently specimens were detected in the North Sea (1932), Mediterranean Sea (1949, but probably as early as 1935), Baltic Sea (1951), Black Sea (1967), and possibly in the Sea of Azov (1967) (Nehring 2011).
The first North Sea records consist of two female specimens, one taken on 10 September 1932 in the Dutch River Zaan near Zaandam, northwest of Amsterdam, and the other collected in December 1934 in Amsterdam harbour (Den Hartog and Holthuis 1951). The authors mention two boiled specimens, male and female, washed ashore near Vlissingen on August 1950. A live specimen was collected from the Noordzeekanaal at Nauerna in July 1951, and four dead specimens washed ashore at Schiermonnikoog on 7 May 1967 (Holthuis 1969). Both live and dead crabs have been found sporadically in Dutch coastal waters over the next decades: dates, locations, sex and conditions are summarized by Adema (1983, 1991), Craeymeersch and Kamermans (1996), ICES WGITMO (2000, 2001, 2006) and Wolff (2005). It should be noted that ovigerous females were found in 1982, 1999 and 2000. In the ports of Amsterdam, Hoek van Holland and Rotterdam specimens of *C. sapidus* are recorded each year since 1995, though detailed information is lacking. In 2002 a first blue crab was observed by a diver in the Eastern Scheldt estuary near the storm surge barrier (Anonymous 2003).
C. sapidus was first recorded from German waters by Kühl (1965) based on a single specimen caught by a fisherman in the outer Elbe estuary near Cuxhaven in a stownet on 12 September 1964. Several records stem from the Weser estuary: a specimen was caught, probably in 1965, near Blexen, between the outer and inner Weser estuary (Nehring *et al.* 2008), two specimens were found in 1990 in the cooling water inlet of a power station at Bremen harbour on the inner Weser estuary (Nehring *et al.* 2008), and in November 1998 an adult was caught in an eel pot together with several Chinese mitten crabs (*Eriocheir sinensis*) in the inner part of the Weser estuary (Geiter 2000). All but one crab of undetermined sex were male crabs. The first recorded adult female was caught by a shrimp fisherman in the outer Weser estuary on 20 July 2007 (Nehring *et al.* 2008). The most recent female specimen was collected on 26 May 2008 by a shrimp fisherman in the East Frisian Wadden Sea at the Accumersieler Balje, the tidal inlet between the German islands Baltrum and Langeoog. The female, kept in a public marine aquarium at 30 psu and 19°C, laid on the14th day millions of eggs, which hatched after 2 weeks (Nehring and van der Meer 2010).
The first British record of *C. sapidus* was trawled from the East English Channel sea area, 1 mile off Littlestone on Sea, Kent during September 1979 (Ingle 1980, Clark 1984). On the British North Sea coast a male was collected by an angler from Dunham Bridge, approximately 38 miles up the River Trent, a tributary of the Humber, in August 1982 (Clark 1984). A single specimen was caught, probably in 2000, by an eel fisherman in the River Thames near Erith (P.F. Clark pers. comm. in Nehring 2011).
The first Belgian record of *C. sapidus* dates from November 1981. A dead specimen was discovered

in the cooling water system of a chemical plant at Antwerp which water originates in the River Scheldt (Adema 1991). The first live specimen was found by a child on August 1984 at Knokke-Heist, near the harbour of Zeebrugge (Rappé 1985). In October 1993 a male specimen was collected in the artificially heated waters of the cooling system of the nuclear plant at Doel on the inner Scheldt estuary (Van Damme and Maes 1993). At the same site a single blue crab was detected between July 1994 and June 1995 (Maes *et al.* 1998). Between 1995 and 2001 several crabs, including ovigerous females, were found in Belgian coastal waters, though no additional information is given (ICES WGITMO 2001). In November 2002 an adult male crab was fished off Oostende (ICES WGITMO 2003). Between August and November 2004 an adult male and three female specimens, one of which ovigerous, were caught by shrimp fishermen in the Western Scheldt estuary and transferred to public aquaria (Kerckhof and Haelters 2005). Between July and October 2006 at least seven female specimens including several ovigerous specimens were brought in by shrimp fishermen. They related that additional specimens have been fished, and indeed, several dried specimens are on exhibit in the Nieuwpoort fishmarket (ICES WGITMO 2007, F. Kerckhof pers. comm. in Nehring 2011).
Only two records are known from the Baltic Sea: on 20 September 1951 a female was captured by a plaice net northeast of Copenhagen and kept alive for a year in a public aquarium (Wolff 1954), in 2007 an adult male was caught off Skagen, Northern Jutland, between the Kattegat and the Skagerrak (Tendal and Flintegaard 2007).

Pathways of introduction

Although *C. sapidus* has been repeatedly collected over the past century in many locations in European seas (Nehring 2011), it is unknown how the species had arrived in Europe. It was proposed that multiple independent introductions had taken place, possibly utilizing different pathways, even to the same sites (Nehring 2011).
Already Bouvier (1901), who published the first occurrence of the species in Europe, has speculated on the manner of its arrival. The specimen could have arrived in the harbour of Rochefort through shipping, in a ship's boat or in a corner full of water, or in vessels' fouling community. However, it is unlikely the crab with its affinity to brackish water would cross oceans on ships' hulls or as suggested by Wolff (1954) with floating seaweeds. The latter pathway would also fail to explain the presence of the crabs in remote areas such as the northern Adriatic, eastern Mediterranean or Black Sea (Nehring 2011). Transport in ballast tanks is considered the most likely vector because, in its native range, *C. sapidus* is abundant next to major shipping routes and had been found in its introduced range initially in or nearby ports, where ballast water are discharged (Wolff 1954, Holthuis and Gottlieb 1955). Direct evidence was supplied recently, when three living specimens were found in ballast tanks but none on ships' hulls (Gollasch 1996). During ballast intake, juveniles, or more likely planktonic larvae, may be by swept in with the water (Holthuis and Gottlieb 1955, Mizzan 1993). As the larval development of *C. sapidus* lasts from about 37-69 days (Hill *et al.* 1989), this is long enough to make vessel transport plausible.
In other cases, different transport mechanisms could be involved. The species, commercially valuable (from *sapidus* (Latin) = "savory"), may have been introduced intentionally or has been accidentally released from holding tanks in which live crabs had been imported for human consumption or for the aquarium trade (ICES WGITMO 2006). Records of intact but boiled specimens on the Dutch North Sea coast (Wolff 2005), seem to indicate that *C. sapidus* is consumed aboard vessels, and it is possible that leftovers (boiled or live specimens) were thrown overboard (cf. Nehring *et al.* 2008).
C. sapidus is most valuable in commercial fisheries, providing a highly acceptable, nutritious product worth several million dollars annually in the USA alone. Consequently the intentional release of blue crabs into Europe to support a fishery should not be excluded as suggested by Artüz (1990) for the northern Aegean Sea. However, our knowledge about worldwide transfers of blue

crabs (and other alien species) including evidences for their ultimately fates is extremely limited so far. An improvement of providing of specific data is indispensable for a forward looking alien management.

Alien status in region

The frequency and the increased number of records, including ovigerous females, suggest that *C. sapidus* has become established in Dutch and Belgian coastal waters since the 1990s (Wolff 2005, Kerckhof *et al.* 2007) (see figure 3 and table 1). As successfully reproducing populations had not been observed so far, *C. sapidus* is considered as a non-established alien species in Denmark and in Germany (Tendal and Flintegaard 2007, Nehring 2011). In other NOBANIS countries no blue crabs have yet been observed in the wild.

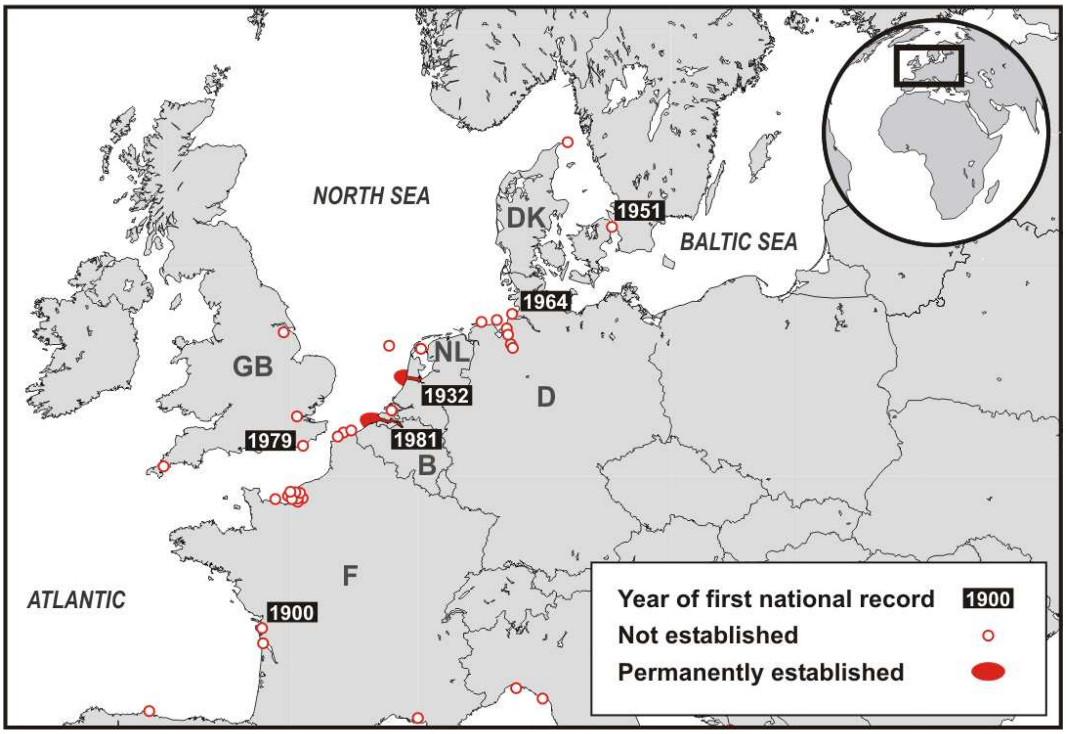

Fig. 3. Occurrence of blue crabs (*Callinectes sapidus*) in North European waters (Main data sources see text and Nehring 2011).

Country	Not found	Not established	Rare	Local	Common	Very common	Not known
Austria	X						
Belgium			X				
Czech Republic	X						
Denmark		X					
Estonia	X						
European part of Russia	X						
Finland	X						
Faroe Islands	X						
Germany		X					
Greenland	X						
Iceland	X						

Ireland	X	
Latvia	X	
Lithuania	X	
Netherlands		X
Norway	X	
Poland	X	
Sweden	X	

Table 1. The frequency and establishment of *Callinectes sapidus*, please refer also to the information provided for this species at www.nobanis.org/search.asp. Legend for this table: **Not found** –The species is not found in the country; **Not established** - The species has not formed self-reproducing populations (but is found as a casual or incidental species); **Rare** - Few sites where it is found in the country; **Local** - Locally abundant, many individuals in some areas of the country; **Common** - Many sites in the country; **Very common** - Many sites and many individuals; **Not known** – No information was available.

Ecology

Habitat description

C. sapidus lives in estuaries and marine embayments from the water's edge to approximately 90 m, mainly in the shallows to depth of 35 m, on muddy and sandy bottoms. It is extremely euryhaline. Within its native range, crabs occupy water ranging from a near-ocean salinity of 34 psu to freshwater in rivers as far as 195 km upstream from the coast (Hill *et al.* 1989).

Reproduction and life cycle

C. sapidus has a complex life cycle and is partitioned by habitat relative to age and gender. Juvenile crabs go through 18-20 molts to reach sexual maturity in 10 to 20 months. Low temperatures (<10 °C) prevent molting and decrease growth rates in blue crabs. Generally, growth occurs at temperatures over 15 °C, and is mostly unaffected by salinity conditions. Females mate only during the soft shell state after they molt. The sperm from this mating is stored in seminal receptacles and may be used as often as a female spawns, generally two or more times during a one to two year period. Males may mate several times in a spawning season, but the amount of sperm decreases after the first mating. After mating in the upper reaches of estuaries, females move seawards or to nearshore coastal waters to spawn. Females spawn 2-6 million eggs per brood, which are brooded for about two weeks during which time the colour of the egg mass changes from orange to dark brown. Zoeal development may require 31 to 49 days, depending on salinity and temperature, but development time has been shown to be variable even in a single salinity-temperature regime. On the average, only one out of every million eggs survives to become a mature adult.

In particular water temperature seems an important factor for long-term establishment. Adult blue crabs are more tolerant to low temperatures than are many species of fishes and shrimps. Their ability to burrow into the substrate apparently enables them to be insulated from cold water, a good prerequisite to survive in suboptimal temperature regimes. However, hatching of blue crab eggs requires water temperatures of more than 19°C. Larval blue crabs, reared at temperatures less than 21°C, did not develop beyond the first zoeal stage.

Blue crabs feed on a wide variety of bivalves, other benthic invertebrates, fishes, plants material and also detritus and carrion. At all life stages, *C. sapidus* serves as food to other species, including many fish, sea turtles, some wading birds, diving ducks, and raccoons.

Key references: Van Engel 1958, Williams 1984, Hill *et al.* 1989.

Dispersal and spread
Beyond the initial human-mediated introduction, the rapid and widespread dispersal from the areas of introduction may also be an important factor in arriving to new habitats in broader environs. Among larval transport by water currents, occasional records of adult blue crabs in new areas may likely be explained in some cases by long-distance migrations of blue crabs from areas of their established populations – like in cases of records of adult specimens of the Chinese mitten crab (*Eriocheir sinensis*) in the Baltic (Ojaveer *et al.* 2007). Hill *et al.* (1989) underline that adult blue crabs are excellent swimmers and can migrate long distances over the sea bottom (Stimpson erected the Genus Callinectes in 1860 and derived it from *calos* (Greek) = *strenuus* (Latin) = "strenuous" and *nectes* (Greek) = *natator* (Latin) = "swimmer"). Especially female blue crabs can move several hundred kilometers (Hill *et al.* 1989), wherein just fertilized or ovigerous females have an enhanced potential for bio-contamination of new habitats. A passive dispersal of juvenile or adult specimens of *C. sapidus* as hitchhikers on ships' hulls is also possible, but probably for relatively short distances only (Nehring 2011). But not every introduction was and will be successfully in the long run. Among insufficient habitats and environmental pollution, too low water temperatures seem an important factor for the non establishment of *C. sapidus* especially in northern Europe (Nehring 2011). However, indications suggest that water temperatures will become warmer due to continuing climate change (e.g. Mackenzie and Schiedek 2007). In consequence, the temperature regime will probably become more favourable for blue crabs in not yet occupied areas in the near future.

Impact

Affected habitats and indigenous organisms
Together with r-selected life history traits (high fecundity and dispersal capacity, fast growth), the broad environmental tolerances predispose *C. sapidus* as a likely successful invader (Hill *et al.* 1989). Blue crabs perform a variety of ecosystem functions and can play a major role in energy transfer within estuaries and lagoons. At various stages in the life cycle, blue crabs serve as both prey and as consumers of plankton, small invertebrates, fish, and other crabs. They are important detritivores and scavengers and, if food is in short supply, even also cannibals (Hill *et al.* 1989). They are aggressive towards other species, and compete with other crabs for food and space (Gennaio *et al.* 2006, Nehring *et al.* 2008). *C. sapidus* is also a host to several parasites and diseases, some with a high potential to cause mass mortalities (e.g. Reinhard 1950, Messick and Sindermann 1992). Thus the introduction of blue crabs can have significant consequences to the ecology of the invaded environments. Despite the nomination of *C. sapidus* as one of the 100 'Worst Invasive Alien species in the Mediterranean' (Streftaris and Zenetos 2006), up to now the definite long term impacts of *C. sapidus* to non-native environments are unknown although since decades this alien species has established distinct permanent populations especially in the eastern Mediterranean Sea where particularly high abundances of blue crabs could be observed (Nehring 2011). Intensified research in this field should be undertaken.

Genetic effects
Genetic effects, such as hybridisation with native species are unlikely.

Human health effects
The occurrence of *C. sapidus* could be an important harmful factor in the human health system as well as in the tourism sector because blue crabs have been implicated as carriers of strains of the bacterium *Vibrio cholerae* which are responsible for outbreaks of human cholera (Hill *et al.* 1989). Prey preference for filter-feeding organisms, such as clams and mussels, make the blue crab a candidate for algal toxins (microcystins) contamination, therefore making this commercially

important edible crab species a potential vector of these toxins to humans (Garcia *et al.* 2010).

Economic and societal effects (positive/negative)
C. sapidus supports an important fishery in its native range along the Atlantic coast of North-America as well as in its introduced range in the eastern Mediterranean Sea. However, due to climate change and its supposed positive effects on the occurrence of blue crabs, *C. sapidus* might well become a candidate for a target species in commercial fishery elsewhere. This could be a real scenario for example in the Adriatic Sea, at the European Atlantic coast and in the North Sea (Nehring 2011). Otherwise in this context it will be an interesting question whether *C. sapidus* will significantly reduce stocks of the introduced Pacific oyster (*Crassostrea gigas*), which is commercially used in several European countries, because adult blue crabs prefer molluscs such as oysters as their primary food sources (Hill *et al.* 1989). Blue crabs are reported to mutilate fish caught in traps and trammel nets, and tear those nets (Banoub 1963, Beqiraj and Kashta 2010). However, comprehensive analyses about the economic benefits and disadvantages of *C. sapidus* in its introduced range have not yet been done. This should be put into action now.

Management approaches

Prevention methods
It is very difficult to control the distribution of aquatic invasive species and prevent their spread once they have become established in the area. Management of ballast water and cleaning ship hulls can be considered as prevention measures against *C. sapidus*. However, the invasion history of *C. sapidus* in European and adjacent waters is unknown in detail until now. Identification of source populations and reconstruction of possible pathways of invasion are key issues in our understanding of the invasion process and especially in the design of effective measures to minimise introduction and spreading of alien species. Molecular markers provide effective tools to investigate invasion histories, as actually shown for the occurrence of *E. sinensis* in European and North American waters (Hänfling *et al.* 2002). Conducting genetic analyses based on older vouchers as well as on living specimens from different native and non-native occurrences would be an important step for understanding the invasion history of *C. sapidus* in its introduced range.
Due to nature conservation efforts, management instructions were implemented by the appropriate German authority for further dealing with a captured fertilized female specimen, which was directly transferred to a German public marine aquarium (Nehring and van den Meer 2010). The authority decreed that a release of this specimen into the wild would not be allowed. By producing this order the deliberate release of a potentially invasive alien species into German waters was prevented. Additionally the authority required that measures were taken to prevent the water of the aquarium, in which the female crab was held, to reach coastal waters. Otherwise blue crab larvae may reach the environment.

Eradication, control and monitoring efforts
Due to the fact that *C. sapidus* is well established in European and adjacent waters over a period of more than 70 years (Nehring 2011), it is postulated, that it is unrealistic to believe that it could be completely eradicated. Specific fishery may reduce population density and slow down the speed at which it spreads naturally, but it is not an effective control method. Monitoring of the distribution and identifying new populations by cooperation with fishermen to report findings of blue crabs to the authorities provide important information necessary in a management strategy.

Information and awareness
C. sapidus is featured on the *100 Worst Invasive Alien species in the Mediterranean* list and information about this species is found in a lot of publications, fact sheets and on several web sites (see Chapter ”References and other resources”). Due to its relatively scarce occurrence in NOBANIS countries,

however, *C. sapidus* is not the subject of heightened public attention in Northern Europe up to now.

Knowledge and research

Although blue crabs have been recorded from European waters for more than 100 years, knowledge about ecological impacts as well as about economic benefits and disadvantages of *C. sapidus* in its introduced range is limited. Today no specific research programme is in place. However, it is possible that the occurrence of *C. sapidus* has relevant effects and should be investigated. So much more as this alien species may benefit from global warming and may become more abundant in the near future (Nehring *et al.* 2008).

Recommendations or comments from experts and local communities

None.

References and other resources

Contact persons

Stefan Nehring (DE), Federal Agency for Nature Conservation, Konstantinstraße 110, 53179 Bonn, Germany; Phone: +49 228 8491 1444; E-mail: Stefan.Nehring[at]bfn.de

Ulrik Christian Berggreen (DK), Danish Nature Agency, Haraldsgade 53, 2100 Copenhagen, Denmark; Phone: +45 72544829; E-mail: ucb[at]nst.dk

Henn Ojaveer (EE), Estonian Marine Institute, University of Tartu, Vana-Sauga 28, 80031 Parnu, Estonia, Tel + 372 44 33800; + 372 51 58328, Fax + 372 44 33800, E-mail: henn.ojaveer[at]ut.ee

Solvita Strāķe (LV), Latvian Institute of Aquatic Ecology, Daugavgrivas 8, LV-1048, Riga, Latvia; E-mail: solvita.strake[at]lhei.lv

Ingrid Bysveen (NO), Directorate for Nature Management, Tungasletta 2, N-7485 Trondheim. Norway; Phone: +47 73580739; E-mail: Ingrid.bysveen[at]dirnat.no

Links

Species Fact sheet - *Callinectes sapidus*, a world overview
FAO - Food and Agriculture Organization of the United Nations

Species Fact sheet - *Callinectes sapidus*, a world overview
WoRMS - World Register of Marine Species

Species Fact Sheet - *Callinectes sapidus* in Europe
DAISIE - Delivering Alien Invasive Species Inventories for Europe

Species Fact Sheet - *Callinectes sapidus* in the Baltic Sea
BSASD - Baltic Sea Alien Species Database

Species Fact Sheet - *Callinectes sapidus* in Sweden
Frammandearter - Alien species in Swedish seas and coastal areas

Species Fact Sheet - *Callinectes sapidus* in the Mediterranean Sea
CIESM - International Commission for the Scientific Exploration of the Mediterranean Sea

Species Fact Sheet - [Blue crab (*Callinectes sapidus*)]() (USA)
GSMFC - Gulf States Marine Fisheries Commission

Species Fact Sheet - [The Blue Crab Archives]() (USA)
Steven C. Zinski

Species Fact Sheet - [Blue crab (*Callinectes sapidus*)]() (Texas)
TPWD - Texas Park and Wildlife Department

References

Adema, J.P.H.M. 1983. Nogmaals de blauwe zwemkrab, *Callinectes sapidus* Rathbun, 1896. - Zeepaard 43: 14.

Adema, J.P.H.M. 1991. De krabben van Nederland en België (Crustacea, Decapoda, Brachyura). - Nationaal Natuurhistorisch Museum, Leiden.

Anonymous, 2003. De Blauwe zwemkrab is nu ook in de Oosterschelde aangetroffen. [Web publication]().

Artüz, I. 1990. Mavi yengecin serüvenleri. - Cumhuriyet Bilim Teknik 148: 6.

Banoub, M.W. 1963. Survey of the Blue-Crab *Callinectes sapidus* (Rath.), in Lake Edku in 1960. - Alexandria Institute of Hydrobiology, Notes and Memoirs 69: 1-20.

Beqiraj, S. and Kashta, L. 2010. The establishment of blue crab *Callinectes sapidus* Rathbun, 1896 in the Lagoon of Patok, Albania (south-east Adriatic Sea). - Aquatic Invasions 5: 219-221.

Bouvier, E.L. 1901. Sur un *Callinectes sapidus* M. Rathbun trouvé à Rochefort. - Bull. Mus. hist. nat. Paris 7: 16-17.

Clark, P. 1984. Recent records of alien crabs in Britain. - Naturalist 109: 111-112.

Craeymeersch, J.A. and Kamermans, P. 1996. Waarnemingen van de blauwe zwemkrab *Callinectes sapidus* in de Oosterschelde. - Zeepaard 56: 21-22.

Den Hartog, C. and Holthuis, L.B. 1951. De Noord-americaanse “Blue Crab” in Nederland. - Levende nat. 54: 121-125.

FAISV, 2006. Blue crab (*Callinectes sapidus*). - Främmande arter i svenska hav. [Web publication]().

Food and Agriculture Organization, 2007. Species Fact Sheet *Callinectes sapidus* Rathbun, 1896. [Web publication]().

Garcia, A.C., Bargu, S., Dash, P., Rabalais, N.N., Sutor, M., Morrison, W. and Walker, N.D. 2010. Evaluating the potential risk of microcystins to blue crab (*Callinectes sapidus*) fisheries and human health in a eutrophic estuary. - Harmful Algae 9: 134-143.

Geiter, O. 2000. Blaukrabbe in der Weser gefangen. - Neozoen Newsl. 3: 9.

Gennaio, R., Scordella, G. and Pastore, M. 2006. Occurrence of blue crab *Callinectes sapidus* (Rathbun,1986 Crustacea, Brachyura), in the Ugento ponds area (Lecce, Italy). - Thalassia Salent. 29: 29-39.

Gollasch, S. 1996. Untersuchungen des Arteintrages durch den internationalen Schiffsverkehr unter besonderer Berücksichtigung nichtheimischer Arten. - Verlag Dr. Kovac, Hamburg.

Hänfling, B., Carvalho, G.R. and Brandl, R. 2002. mt-DNA sequences and possible invasion pathways of the Chinese mitten crab. - Mar. Ecol. Prog. Ser. 238: 307-310.

Hill, J., Fowler, D.L. and Avyle, M.V. van den 1989. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Mid-Atlantic) - Blue crab. - U.S. Army Corps of Engineers, Vicksburg.

Hill, K. 2004. Species fact sheet *Callinectes sapidus* (Blue Crab). - Smithsonian Marine Station at Fort Pierce. [Web publication]().

Holthuis, L.B. 1969. Enkele interessante Nederlandse Crustacea. Bijdragen tot de faunistiek van Nederland. I. - Zool. Bijdr. Leiden 11: 34-48, pl. 1.

Holthuis, L.B. and Gottlieb, E. 1955. The occurence of the american Blue Crab, *Callinectes sapidus* Rathbun, in Israel waters. - Bull. Res. Counc. Israel 5B: 154-156.

ICES WGITMO, 2000. Report of the Working group on Introductions and Transfers of marine Organisms, Parnu, Estonia, 27-29 March 2000. - ICES CM 2000/ACME:07.

ICES WGITMO, 2001. Report of the Working group on Introductions and Transfers of marine Organisms, Barcelona, Spain, 21-23 March 2001. - ICES CM 2001/ACME:08.

ICES WGITMO, 2003. Report of the Working group on Introductions and Transfers of marine Organisms, Vancouver, Canada, 26-28 March 2003. - ICES CM 2003/ACME:04.

ICES WGITMO, 2006. Report of the Working group on Introductions and Transfers of marine Organisms, Oostende, Belgium, 16-17 March 2006. - ICES CM 2006/ACME:05.

ICES WGITMO, 2007. Report of the Working group on Introductions and Transfers of marine Organisms, Dubrovnik, Croatia, 21-23 March 2007. - ICES CM 2007/ACME:05.

Ingle, R.W. 1980. British crabs. - British Museum (Natural History), London.

Kerckhof, F. and Haelters, J. 2005. Enkele opmerkelijke waarnemingen en strandingen in 2004 en 2005. - De Strandvlo

25: 101-105.
Kerckhof, F., Haelters, J. and Gollasch, S. 2007. Alien species in the marine and brackish ecosystem: the situation in Belgian waters. - Aquatic Invasions 2: 243-257.
Kühl, H. 1965. Fang einer Blaukrabbe, *Callinectes sapidus* Rathbun (Crustacea, Portunidae) in der Elbmündung. - Arch. Fisch. Wiss. 15: 225-227.
Mackenzie, B.R. and Schiedek, D. 2007. Daily ocean monitoring since the 1860s shows record warming of northern European seas. - Global Change Biol. 13: 1335-1347.
Maes, J., Taillieu, A., van Damme, P.A. et al. 1998. Seasonal patterns in the fish and crustacean community of a turbid temperate estuary (Zeeschelde Estuary, Belgium). - Estuar. Coast. Shelf Sci. 47: 143-152.
Messick, G.A. and Sindermann, C.J. 1992. Synopsis of principal diseases of the blue crab, *Callinectes sapidus*. - NOAA Technical Memorandum, Woods Hole.
Mizzan, L. 1993. Presence of swimming crabs of the genus *Callinectes* (Stimpson) (Decapoda, Portunidae) in the Venice Lagoon (North Adriatic Sea - Italy): first record of *Callinectes danae* Smith in European waters. - Boll. Mus. civ. Stor. nat. Venezia 42: 31-43.
Nehring, S. 2011. Invasion history and success of the American blue crab *Callinectes sapidus* Rathbun, 1896 in European and adjacent waters. - In: Galil, B.S., Clark, P.F. and Carlton, J.T. (eds.), In the Wrong Place - Alien Marine Crustaceans: Distribution, Biology and Impacts. Invading Nature - Springer Series in Invasion Ecology 6: 607-624.
Nehring, S. and Meer, U. van der 2010. First record of a fertilized female blue crab, *Callinectes sapidus* Rathbun, 1896 (Crustacea: Decapoda: Brachyura), from the German Wadden Sea and subsequent secondary prevention measures. - Aquatic Invasions 5: 215-218.
Nehring, S., Speckels, G. and Albersmeyer, J. 2008. The American blue crab *Callinectes sapidus* Rathbun on the German North Sea coast: Status quo and further perspectives. - Senckenbergiana marit. 38: 39-44.
Ojaveer, H., Gollasch, S., Jaanus, A. et al. 2007. The Chinese mitten crab *Eriocheir sinensis* in the Baltic Sea – a supply-side invader? - Biol. Invasions 9: 409-418.
Rappé, G. 1985. Vestigt de blauwe zwemkrab, *Callinectes sapidus* zich blijvend in de Zuidelijke Noordzee? - De Strandvlo 5: 8-11.
Streftaris, N. and Zenetos, A. 2006. Alien marine species in the Mediterranean - the 100 ‘Worst Invasives’ and their impact. - Medit. Mar. Sci. 7: 87-118.
Tendal, O.S. and Flintegaard, H. 2007. Et fund af en sjælden krabbe i danske farvande: den blå svømmekrabbe, *Callinectes sapidus*. - Flora Fauna Århus 113: 53-56.
Van Damme, P. and Maes, J. 1993. De Blauwe Zwemkrab *Callinectes sapidus* Rathbun, 1896 in de Westerschelde (Belgium). - De Strandvlo 13: 120-121.
Van Engel, W.A. 1958. The blue crab and its fishery in Chesapeake Bay. Part 1: Reproduction, early development growth, and migration. - Comm. Fish. Rev. 20: 6-17.
Williams, A.B. 1984. Shrimps, Lobsters, and Crabs of the Atlantic coast of the Eastern United States, Maine to Florida. - Smithsonian Institution Press, Washington.
Wolff, T. 1954. Tre ostamerikanske krabber fundet i Danmark. - Flora Fauna Århus 60: 19-34.
Wolff, W.J. 2005. Non-indigenous marine and estuarine species in The Netherlands. - Zool. Med. 79-1: 1-116.

Date of creation/modification of this species fact sheet: 07-03-2012