NOBANIS – Invasive Alien Species Fact Sheet

Elodea canadensis, Elodea nuttallii and Elodea callitrichoides

Author of this fact sheet: Melanie Josefsson, Department of Natural Resources, Swedish Environmental Protection Agency, SE106 48 Stockholm, Sweden, Telephone +46 10 698 1541, Melanie.Josefsson@naturvardsverket.se

Bibliographical reference – how to cite this fact sheet:
Josefsson, M. (2011): NOBANIS - Invasive Species Fact Sheet – *Elodea canadensis, Elodea nuttallii and Elodea callitrichoides* – From: Online Database of the European Network on Invasive Alien Species – NOBANIS www.nobanis.org, Date of access x/x/201x.

Species description

Scientific name: *Elodea canadensis* Michx., Hydrocharitaceae
Synonyms: *Elodea canadensis*: *Elodea brandegeae* St. John, *Elodea latifolia* Caspa, *Elodea ioensis* Wylie, *Anacharis canadensis*

Scientific name: *Elodea nuttallii* Planch. St. John, Hydrocharitaceae
Synonyms: *Anacharis occidentalis* (Pursh) St. John, *Anacharis nuttallii* Planchon, *Elodea columbiana, Elodea minor* Farw., *Anacharis occidentalis* (Pursh) Marie-Victorin, *Serpicula occidentalis* Pursh, *Elodea canadensis* var. angustifolia (Britton ex Rydb.) Farw.

Scientific name: *Elodea callitrichoides* (Rich.) Casp, Hydrocharitaceae
Synonyms: *Elodea ernstiae* H. St John

Common names
Elodea canadensis: Canadian waterweed (GB), Kanadische Wasserpest (DE), almindelig vandpest (DK), Kanada vesikatk (EE), (Kanadan) vesirutto (FI), Kanadine elodeja (LT), Kanādas elodeja (LV), Brede Waterpest (NL), Moczarka kanadyjska (PL), элодея канадская (RU), Vattenpest (SE), Vasspest (NO)

Elodea nuttallii: Nuttall's waterweed (GB), Schmalblättrige Wasserpest; Nuttalls Wasserpest (DE), smalbladet vandpest (DK), Kiehkuravesirutto (FI), Nutalla elodeja (LV), Smalle Waterpest (NL), Smal vattenpest (SE), Smal vasspest (NO)

Elodea callitrichoides: Greater water-thyme (GB), South American waterweed (US), Argentinische Wasserpest (DE), Argentinsk vattenpest (SE)




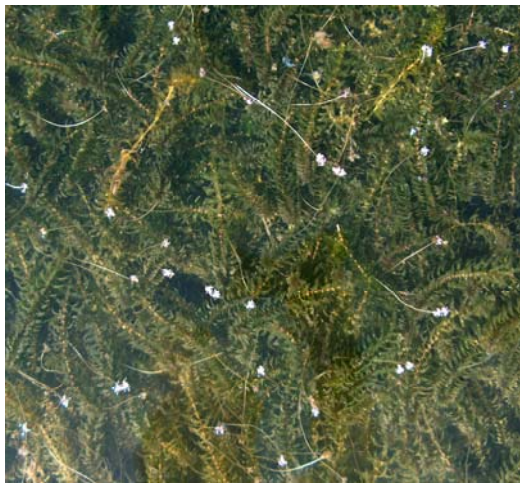

Fig. 1. 2. 3 and 4. *Elodea canadensis***,** photo by Paul Evald Hansen.


Fig. 5 and 6. *Elodea nuttallii*, photo by Paul Evald Hansen.

Fig. 7. *Elodea Canadensis* (left) *and* ***Elodea nuttallii*** (right)**,** photo by Paul Evald Hansen.

Species identification

Elodea canadensis is a submerged aquatic plant. Its stems may grow up to several meters long with whirls of 3 leaves around the stem. The leaves are flat and 6 - 15 mm long, 1.5 - 4 mm broad, thin, dark green and finely serrated. The roots are white and threadlike. *Elodea canadensis* is dioecious and flowers in June - August. The flowers are white-violet, about 4 mm broad and are produced at the tip of the stalk and rise to or above the water surface. Vegetative reproduction by fragmentation or specialized buds dominates in both native and introduced populations (Bowmer et al. 1984, Les 1988).

Elodea nuttallii is very similar to *Elodea canadensis*. Its leaves are however shorter (6 – 13 mm) mm) and narrower (1.5 mm). The leaves are folded along the midrib and bent like claws. *E. nuttallii* is in general smaller and paler than *E. canadensis* and its stalk is often more branched.

Hybrids between *E. canadensis and E. nuttallii* may occur naturally (Cook & Urmi-König 1985).

Elodea callitrichoides is very similar to *E. canadensis* and *E. nuttallii*, but has leaves up to 25 mm long and 2 - 5 mm broad, in whorls of 3. The leaves of *E. callitrichoides* are usually flat, spreading and have some straight margins, some usually at least >10 mm long (Bowmer et.al 1995). E. *callitrichoides* has high leaf areas and its leaves are more widely spaced than *E. canadensis* and *E. nuttallii* (Hérault, Bornet & Trémolières 2007).

Native range

Both *Elodea canadensis* and *Elodea nuttallii* are native to temperate North America. *Elodea canadensis* is common in the Great Lakes region, around the St Lawrence Valley and the Pacific West Coast. *E. callitrichoides* is native to temperate South America.

Alien distribution

History of introduction and geographical spread
Elodea canadensis was first observed in Europe in 1836, in an Irish pond, where it had already been established for some time. It has been introduced to a large number of European countries and was first reported in Scotland in 1854, in Germany near Berlin in 1859 and also in Poland at about this time. The first report of *E. canadensis* in Scandinavia is from Denmark in 1870, Sweden in 1871 and Finland in 1884. In Finland *E. canadensis* was intentionally planted in the Botanical Garden of the University of Helsinki (Hintikka 1917), from which it spread with water and birds to the entire country. Although *E. canadensis* was first observed in Norway near Oslo in 1925, it did not begin to spread to other areas until the 1960s. *E. canadensis* was observed for the first time in the European part of Russia in 1880, in Latvia in 1872, in Lithuania in1884 and in Estonia in 1905.

Elodea canadensis is now widespread globally and is considered a noxious weed in Asia, Africa, Australia and New Zealand (Bowmer *et al.* 1995).

Elodea nuttallii probably came to Europe from North America during the 20th century. The first report of the species in Great Britain is from 1914, when it was first identified as *Hydrilla verticillata*. It was correctly identified as *Elodea nuttallii* in 1974. In the NOBANIS region, the first record is from Belgium in 1939, the Netherlands in 1941 and Germany in 1953, in a botanical garden. *E. nuttallii* was first reported in Denmark in 1974, in Ireland in 1984 (DAISIE 2009), in Sweden in 1991 (Anderberg 1992) and in Norway in 2006 (Imesland 2008). It is very possible that *E. nuttallii* has earlier been found in other European countries, but because of its similarity to *E. canadensis* may have been misidentified.

Elodea callitrichoides was first reported in Europe in 1958 in the Alsace region. It is established in Austria, France, Ireland and the UK (Greulich and Trémoliéres 2006, DAISIE 2009). In Germany only some not established populations occur (Hussner, pers. comm.). *E. callitrichoides* is often misidentified as *E. nuttallii*.

Pathways of introduction
Elodea canadensis was probably introduced to Europe by planting for ornamental purposes and accidental release from aquariums to natural waters. Another possible vector is through import of timber (Cook & Urmi-König 1985) and packing grass. *Elodea canadensis* and *E. nuttallii* are still sold all over Europe as an ornamental in garden centers and as an aquarium plant (Brunel 2009).

Alien status in the region
Elodea canadensis has been recorded in all countries of the NOBANIS region, with the exception of Iceland, Greenland, the Faroe Islands and the Norwegian islands of Svalbard and Jan Mayen. *E. canadensis* is common all over Denmark (Moeslund *et. al*. 1990). In Sweden it occurs in nutrient rich lakes and slow moving rivers throughout southern and central Sweden and along the coast of Northern Sweden (Larson & Willén 2006). In Norway *Elodea* is found mainly in southeastern Norway, but is now rapidly expanding along the southwestern coast. It is at present known from 60 lakes and 13 rivers, of which 30 % report negative impacts (Artsdatabanken 2009). In Finland, *E. canadensis* is extremely abundant in many lakes and ponds in southern and central Finland and is still expanding its range (Kurtto *el al*. 2001). It occurs in small lakes and bays of larger lakes, in slow moving rivers and in wide ditches and in waters of 30-50 cm depths (Sand-Jensen 2000). It is seldom found in brackish water, but is present in semi-enclosed bays in the Swedish and Finnish coastal waters of the Gulf of Bothnia (Informationscentralerna 2009).

E. nuttallii is becoming more widespread and has displaced *E. canadensis* in many sites in Europe during the past twenty years. *Elodea nuttallii* has become the most common aquatic macrophyte in the Alsatian Rhine floodplain and is the most abundant of the three *Elodea* species (Greulich and Trémoliéres 2006). In the UK there are indications that *E. nuttallii* is now being displaced by another alien species *Lagarosiphon major* (National Biodiversity Data Centre 2009).

Country	Not found	Not established	Rare	Local	Common	Very common	Not known
Austria						X	
Belgium						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	
Norway					X		
Poland						X	
Sweden					X		

Table 1. The frequency and establishment of *Elodea canadensis*, please refer also to the information provided for this species at www.nobanis.org/search.asp.

Country	Not found	Not established	Rare	Local	Common	Very common	Not known
Austria						X	
Belgium						X	
Denmark			X				
Estonia	X						
European part of Russia	X						
Finland	X						
Germany						X	
Greenland	X						
Ireland					X		
Latvia	X						
Lithuania	X						
Norway			X				
Poland			X				
Sweden				X			

Table 2. The frequency and establishment of *Elodea nuttallii*, please refer also to the information provided for this species at www.nobanis.org/search.asp.

Country	Not found	Not established	Rare	Local	Common	Very common	Not known
Austria		X					
Belgium	X						
Denmark	X						
Estonia	X						
European part of Russia	X						
Finland	X						
Germany		X					
Greenland	X						
Iceland							
Ireland	X						
Latvia	X						
Lithuania	X						
Poland	X						
Sweden		X					

Table 3. The frequency and establishment of *Elodea callitrichoides*, please refer also to the information provided for this species at www.nobanis.org/search.asp

Legend for these tables: **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

Elodea canadensis and E. nuttallii are common in both nutrient rich lakes and in slow flowing rivers and prefers calcium rich water with pH 6.5 - 10. A prerequisite for growth is the availability of reduced iron and bicarbonate as a carbon source (Spicer & Catling 1988, Larson 2003). Both *Elodea* species are commonly found in shallow water, preferably not deeper than 3 m, but have been reported from depths as low as 5 - 6 m (Artsdatabanken 2009). *E. nuttallii* may be able to grow in deeper water than *E. canadensis* (Anderberg 2005). Both *Elodea* species are tolerant of low light conditions (Mielecki & Piecznska 2005) and grow well even in turbid water.

E. canadensis can occur in brackish water and tolerates salinities up to 2.5 per mille (Sand-Jensen 2000). *E. canadensis* is quite tolerant to cold water (optimum temperature between 10 and 25° C), but does not survive freezing. Thus it does not invade regulated lakes where shallow areas are left dry during the winter. An exception is found in Northeastern Finland, where climatic factors do not seem to prevent the species from spreading (Sand-Jensen 2000).

E. canadensis has a preference for firm, fine grained sediments with a high content of nutrients and minerals. The species often invades newly created shallow ponds with high light availability and low competitive pressure, where it forms large masses.

Elodea nuttallii is mainly found in eutrophic, oligo- or mesoprobic waters with a certain degree of organic pollution, while *E. canadensis* has its main distribution in mesotrophic waters (Best,

Woltman and Jacobs 1996). *E. nuttallii* is tolerant of disturbances, oil pollution and salinities up to 14 parts per mille (CAPM 2004). In Sweden, it grows together with *e.g Potamogeton*, *Callitriche*, and *Ceratophyllum* species(Andersson & Josefsson 2001). In Norway, stands of *E. nuttallii* are found in a low alkalinity lake (Ca 4 mg/l), together with i.a. *Isoetes lacustris* (Mjelde 2009).

Both *E. canadensis* and *E. nuttallii* are highly invasive. *E. nuttallii* has generally been seen to have a competitive advantage over *E. canadensis* in nutrient rich waters and has replaced it in many sites. However, in Germany it has been seen that *E. canadensis* has a competitive advantage over *E. nuttallii* in eutrophic conditions (J. Klinck per. comm.). This competitive ability may be due to *E. nuttallii*'s higher colonisation ability and faster growth under eutrophic conditions. Because regeneration of *E nuttallii* is higher than *E. canadensis* in the spring, *E. nuttallii* may have a competitive advantage where both species are found together (Barrat-Segretain *et al.* 2002). The faster growing *E. nuttallii* may create a canopy close to the water surface which prevents light from reaching *E. canadensis* and other plants. *E. canadensis* may have a weaker ability to compete for light than *E. nuttallii*, which may favour the growth of *E nuttallii* where both species are present (Barrat-Segretain & Elger 2004). The growth of *E. nuttallii* is also stimulated by nitrogen fertilization and benefits from an excess of ammonium (Dendéne *et al.* 1993).

Reproduction and lifecycle
E. canadensis and *E. nuttallii* are dioecious, i.e. the male and female reproductive organs are situated on different individuals. Only female plants are present in the NOBANIS region. In Europe reproduction of both *E. canadensis* and *E. nuttallii* is thought to be only vegetative, as male plants have not been reported since 1903 (Cook & Urmi-König 1985). Even very small plant fragments are able to form roots from nodes and start growing. Vegetative reproduction is also common in North America even when both male and female plants are present (Larson & Willén 2006). *Elodea* overwinters under the ice. In the spring *Elodea* stems start growing from winter dormant apices.

Local dispersal
Dispersal of *Elodea* is very fast and effective because of its ability to reproduce vegetatively. Plant fragments and winter dormant buds are transported downstream in a water system by wind and wave action that then root in the sediment. Transport over land can occur with water birds, mainly geese and swans (Sand-Jensen 2000). More important however, is spread by humans. Movement of small recreational boats between lakes seems to be an important dispersal factor. A critical factor for dispersal of *E. canadensis* and *E. nuttallii* is that propagules do not tolerate drying (Sand-Jensen 2000).

Impact

Affected habitats and indigenous organisms
Elodea is known for its ability to rapidly develop dense monospecific stands which may fill entire lakes and watercourses and change the balance of the entire ecosystem. These dense stands prevent light from reaching other submerged plant. Aquatic habitats can also be modified because dense stands of *Elodea* limit water movements. In many lakes in Scandinavia, *Elodea* has had a cycle of mass occurrence followed by a collapse of the population in every 5 - 6 years (Sand-Jensen 2000). It has been suggested that rapid growth is initiated in areas where the sediment is iron rich. Growth is rapidly terminated when iron reserves are depleted (Spicer and Catling 1988). Another explanation for the rapid termination of *Elodea* growth is that after mass occurrence, decaying plant biomass depletes oxygen and lowers the pH of the water, thereby weakening the carbon fixation and photosynthesis efficiencies of *Elodea* (Lehtonen 2000).

Elodea species can alter the chemical composition of water by increasing nutrient and organic content. *Elodea* contributes to internal fertilization of the water body by taking up nutrients from the sediment during growth and releasing nutrients to the water column during decomposition. The decomposition of such large amounts of biomass can result in hyper-eutrophication of the lake, in which an oxygen deficit may occur. Resulting anoxic conditions can lead to the release of phosphorus earlier bound to reduced iron. This increased availability of nutrients can contribute to mass microalgae blooms, which in turn contribute to increased levels of eutrophication (Larson & Willén 2006).

One consequence of the establishment of *Elodea* can be that other plant species are displaced because of competition for nutrients, as well as shading effects. *Elodea* is a threat to a number of endangered aquatic plant species, such as *Najas flexilis* in Norway (Rörslett et al. 1986, Brandrud & Mjelde 1999) and *Najas tenuissima* in Finland. This negative effect is most pronounced in more nutrient rich localities where the degree and duration of mass occurrences is greatest.

The effects of *Elodea* on animal life in affected waters can be both positive and negative. *Elodea* offers both food and habitat for many species of zoobenthos. Some water living birds, ***e.g.*** geese and swans, seem to benefit from stands of *Elodea* which offer increased amounts of food (Sand-Jensen 2000). *Elodea* may provide refuge for juvenile crayfish and invertebrates (Hessen, Skurdal & Braathen 2004). In its native range *Elodea* is a prime food for adult crayfish (Lodge 1991), but is not a preferred food for the indigenous crayfish *Astacus astacus*.

Negative effects of *Elodea* on populations of crayfish, zooplankton and fish have been reported as well. Crayfish populations have been observed to have been drastically reduced as a result of habitat loss after ***E. canadensis*** colonized a lake in Norway (Hessen, Skurdal & Braathen 2004). Abiotic conditions may also have contributed to the decrease in the crayfish population, as large fluctuations in oxygen content and pH can be found within dense stands of ***E. canadensis***, due to the intense primary production within the canopy and subsequent higher respiration during the night. Anoxic conditions may occur as *Elodea* dies and is decomposed, which is also very negative for invertebrates and fish. Most zooplankton species seem to have been excluded from dense stands of *Elodea*, which may have caused a loss of food resources for juvenile crayfish and thus impeded recruitment.

The negative effects of *Elodea* species are mainly caused if they form large monospecific mass occurrences and stands. In Latvia ***E. canadensis*** occurs as an accompanying species in macrophytic communities and does not cause harm in for example turbid waters in streams, particularly on sandy substrates.

Genetic effects
No known genetic effects

Human health effects
No known effects to the human health.

Economic and societal effects (positive/negative)
Mass occurrences of ***E. canadensis*** and ***E. nuttallii*** have negative effects on water resources and recreational activities ***e.g.*** fishing, boating and swimming. Dense stands of *Elodea,* which fill entire waters, impede fishing, boating and swimming. In Ireland, hectares of water have become unfishable and unavailable for other aquatic recreational activities due to the growth of ***E. nuttallii*** (National

Biodiversity Data Centre 2009). *Elodea* can clog water intake pipes for hydropower and industrial plants and water works, which can limit use of water for industrial and domestic purposes (Brandrud 1999, Sand-Jensen 2000).

Scrape damage to boat hulls caused by calcium encrusted stands of *Elodea* has been reported from Lake Mälaren, Sweden (Andersson & Josefsson 2001). This phenomenon can occur in hard water lakes during periods of high level of photosynthesis which raises the pH. Calcium then precipitates and encrusts on the fronds of *Elodea* plants.

Elodea can reduce flow in drainage channels which increases the risk of flooding (Larson 2003). Costs for eradication and control measures can be quite substantial.

Elodea canadensis is widely used in constructed wetlands in cold climates for biological remediation of polluted water (Fritioff and Greger 2007). *Elodea* is efficient in uptake of heavy metals and nutrients. *Elodea* is especially efficient in bioaccumulation of cadmium and is particularly tolerant of copper (CAPM 2004).

Management approaches

Prevention methods
Because *Elodea* species are very invasive and have a very high ability to spread within a water system, it is very important to prevent their establishment and stop further dispersal within a region. In Iceland, *Elodea* species are the only plants that are considered a quarantine pest and import to Iceland is prohibited. EPPO considers *Elodea nuttallii* to be a high risk species and has listed it on the *EPPO List of Invasive Plants* (IAP). EPPO recommends that countries restrict the entry and spread of *E. nuttallii* (Brunel 2009). In Norway, import and distribution of *E. canadensis* and *E. nuttallii* is prohibited (DN 2009).

One important measure to prevent the spread of *Elodeas* is to inform the media, schools and society in general about the risks associated with dispersal and spread of these species. Restriction of movements of boats and fishing gear between waters where *Elodea* species are found and other waters at risk could be a way to prevent further spread. Disinfection of boats and fishing equipment could also be a help in avoiding further dispersal (Brandrud & Mjelde 1999).

Eradication, control and monitoring efforts
Biological control using herbivorous fish such as Grass carp (*Ctenopharyngodon idella*) and other bottom-feeding fish is widely used and can give good results. However, using fish to control *Elodea* may also have negative effects, as inefficient digestion of plant material and excretion of body wastes contribute to eutrophication (Di Nino *et al.* 2005). Using fish for control may also increase the biomass of unpalatable plants at the expense of more palatable ones (Bowmer *et al.* 1995).

Mechanical control by cutting or harvesting should only be used when there is no risk of plant fragments being spread by water currents or with machines. Harvesting and cutting can result in more effective dispersal of *Elodea* because of its ability to vegetatively spread by plant fragment. It can however, be a useful method for control in places where *Elodea* is already established or where it will spread to sites where it will not survive (Bowmer *et al.* 1995). Repeated harvesting can possibly deplete available nutrients and result in a reduction in *Elodea* over the long-term. Cutting is most effective if done in July – early August before maximum biomass has been reached. A second cutting may be required late in the season to minimize amount of biomass that needs to be removed

from the water (CAPM 2004). Cut *Elodea* should be removed from the water and left to decompose well away from the water to avoid cut fragments from rooting. A combination of mechanical control followed by treatment with herbicides is recommended by the Centre of Aquatic Plant Management (CAPM 2004).

Other mechanical methods such as covering sediment and regulation of water level in winter to dry out, and in colder climates to freeze *Elodea,* have been used with some success (Sand-Jensen 2000). Covering or shading *Elodea* plants may also be an effective method of control (CAPM 2004). Planting trees on the south side of water bodies or placing opaque sheets over the water may give an adequate amount of shading to control *Elodea* growth.

Chemical control is possible with herbicides, terbutryn and dichlobenil (CAPM 2004). However, it is of greatest importance that if treatment with chemicals and herbicides is being considered, national regulations and recommendations on use of chemicals and herbicides in and near water should be consulted and followed. Many herbicides demands long contact with the plant, which is difficult in flowing water. Herbicides will also kill non-target species. *Elodea* is particularly difficult to control with chemicals and herbicides because of the thick layers of bacteria, algae and detritus often found on the leaves. It is also difficult for chemicals to penetrate dense *Elodea* stands (Bowmer *et al.* 1995). Therefore, repeated applications over several years may be necessary to successfully eradicate *Elodea*.

Information and awareness
Information to the general public and water users is essential to prevent the spread of *Elodea*.

Knowledge and research
The *AquAliens* (Assessing the risks posed by introduced aquatic species and their impact on ecosystems and economy) research program included a project on the ecological effects of freshwater plants in Swedish freshwater (Larson 2007).

References and other resources

Contact persons
Filip Verloove (BE) National Botanic Garden of Belgium, e-mail: filip.verloove@cepa.be

Andreas Hussner (DE), Plant Biochemistry, Heinrich-Heine-University of Düsseldorf, Universitätsstraße 1, D-40225 Düsseldorf; E-mail: hussnera@uni-duesseldorf.de

Arto Kurtto (FI), Editor-in-Chief of Atlas Florae Europaeae, Naturhistoriska Centralmuseet, PL 7 (Unioninkatu 44), FI-00014 Helsingfors Universitet, Finland, e-mail: Arto.Kurtto@helsinki.fi

Tea Huotari (FI), Department of Agricultural Sciences, P.O. Box 27 (Latokartanonkaari 5), FI-00014 University of Helsinki, Finland, Telephone +358 9 19157660, tea.huotari@helsinki.fi

Laura Grīnberga (LV) Institute of Biology, University of Latvia, Miera Str. 3, Salaspils, Latvia, laura.grinberga@gmail.com

Vladimir Papchenkov (RU), Papanin Institute for Biology of Inland Waters Russian Academy of Science, Borok, Yaroslavl District, 152742, Russia, e-mail: papch@mail.ru

Melanie Josefsson (SE), Swedish Environmental Protection Agency, SE106 48 Stockholm, Sweden, Telephon +46 10 698 1541, Melanie.Josefsson@naturvardsverket.se

Links

Alien Species in Swedish Seas (Främmande arter i svenska hav), Fact Sheet on *Elodea canadensis* and *Elodea nuttallii* www.frammandearter.se
http://www.frammandearter.se/0/2english/pdf/Elodea_canad_nuttall.pdf

Artsdatabanken. 2009. Faktaark Vasspest *Elodea canadensis*
http://www2.artsdatabanken.no/faktaark/Faktaark24.pdf

Baltic Sea Alien Species Database: *Elodea canadensis*
www.ku.lt/nemo/directory_details.php?sp_name=Elodea+canadensis

DAISIE fact sheet on *Elodea canadensis*
http://www.europe-aliens.org/pdf/Elodea_canadensis.pdf

Centre for Aquatic Plant Management
http://www.nercwallingford.ac.uk/research/capm/pdf%20files/25%20Elodea%20nuttallii.pdf

Global Invasive Species Database. 2009. *Elodea canadensis.* 100 of the Worst Invasive Alien Species.*http://www.issg.org/database/species/ecology.asp?si=290&fr=1&sts=sss&lang=EN* Date of Access 2009-09-04

Invasive Nonnative Species Website. Invasive nonative aquatic plant, *Elodea canadensis & Elodea nuttallii.* http://138.253.199.114/IAAP%20Web/IAAPwebsite/IASlinks.asp

National Biodiversity Data Center. 2009. Nuttall's Waterweed.
http://invasives.biodiversityireland.ie/wp-content/uploads/Elodea-nuttallii-ID-Centre-.pdf

References

Anderberg, A. 1992. Smal vattenpest, Elodea nuttallii, en ny vattenväxt I den svenska floran. Svensk botanisk tidsskrift 86:43-45

Anderberg, A. 2005. Elodea nuttallii. Den virtuella floran. The Swedish Museum of Natural History, http://linnaeus.nrm.se/flora/mono/hydrocharita/elode/elodnut.html Date of Access: 22 April 2009.

Andersson, B. and Josefsson, M. 2001. The environmental consequences of alien species in Swedish lakes Mälaren, Hjälmaren, Vänern and Vättern, Ambio 30: 514-521.

Artsdatabanken. 2009. Faktaark Vasspest Elodea canadensis http://www2.artsdatabanken.no/faktaark/Faktaark24.pdf Date of access: 2009-04-22.

Barrat-Segretain, M.H. and Elger, A. 2004. Experiments on growth interactions between two invasive macrophyte species. Journal of Vegetation Science 15:109-114.

Barrat-Segretain, M.H., Elger, A., Sagnes, P. And Puijalon, S. 2002. Comparison of three life-hostory traits of invasive Elodea canadensis Michx and Elodea nuttallii (Planch.) H. St John. Aquatic Botany 74:299-313.

Best, E.P.H., Woltman, H. and Jacobs, F.H.H. 1996. Sediment.related growth limitations of Elodea nuttallii as indicated by a fertilization experiment. Freshwater Biology 36: 33.44.

Bowmer, K.H., Mitchell, D.S. and Short, D.L. 1984, Biology of Elodea canadensis Mich. and its management in Australian irrigation systems. Aquatic botany 18: 231-238.

Bowmer, H, K, Jacobs, S. W. L., Sainty, G. R. 1995. Identification, biology and management of Elodea canadensis, Hydrocharitaceae. Journal of Aquatic Plant Management 33: 13-19.

Brandrud, T.E., Mjelde, M. 1999. Vasspest (Elodea canadensis). Effekter på biologisk mangfold. Spredningsmönstre og tiltak. NIVA rapport lnr 4075-99, 51 pp.

Centre for Aquatic Plant Management. 2004. Information Sheet 25: Elodea nuttallii, Nuttall's Pondweed. http://www.nerc-wallingford.ac.uk/research/capm/pdf%20files/25%20Elodea%20nuttallii.pdf Date of access: 2009-04-22.

Brunel, S. 2009. Pathway analysis:aquatic plants imported in 10 EPPO countries. Bullletin OEPP/EPPO Bulletin 39:201-213.
Cook, C.D.K and Urmi-König, K. 1985. Range extension of aquatic vascular plant species. Journal of Aquatic Plant Management 23:1-6.
DAISIE. 2009. Handbook of Alien Species in Europe. Invading nature: Springer series in invasion ecology 3. 399 pp.
Dendéne, M.A., Rolland, T., Trémoliéres, M. and Carbiener, R. 1993. Effect of ammonium ions on the net photosynthesis of three species of Elodea. Aquatic Botany 46: 301-315.
Di Nino, F., Muller, S., Thiébaut, G. 2005. Response of Elodea Nuttallii (Planch.) H. St. John to manual harvesting in the nnorth-east of France. Hydrobiologia 551:147–157.
DN 2009. Forskrift om forbud mot import, utsetting, omsetning og hold av vasspest (Elodea canadensis) og small vasspest (Elodea nuttallii). Fastsatt av Direktoratet for naturforvaltning (DN) 17. februar 2009.
EPPO. 2000. EPPO summaries of phytosanitary regulations. Iceland. http://www.eppo.org/ABOUT_EPPO/EPPO_MEMBERS/phytoreg/summaries/SUE-IS-00.doc Date of Access 2009-09-04.
Fritioff, Å. and Greger, M. 2007. Fate of Cadmium in Elodea canadensis. Chemosphere 67:365-375.
Greulich, S. and Trémoliéres, M. 2006. Present distribution of the genus Elodea in the Alsatian Upper Rhine floodplain (France) with a special focus on the expansion of Elodea nuttallii St.John during recent decades. Hydrobiologia 570:249-255.
Hérault, B., Bornet, A. & Trémolières, M. 2007. Redundancy and niche differentiation among the European invasive Elodea species. Biological Invasions 10: 1099-1107-
Hessen, Skurdal and Braathen 2004. Plant exclusion of a herbivore; Crayfish population decline caused by an invading waterweed. Biological Invasions 6:1573-1464.

Hintikka, T.J. 1917, Kanadalaisesta vesirutosta ja sen levenemisestä Euroopassa, eritoten Suomessa. Luonnon Ystävä 21: 79-90.
Imesland, S. 2008. Smal vasspest (Elodea nuttallii) ny for Norge i Fuglestadåna på Jæren – og generelt om vasspest på Jæren. Blyttia 66 (2): 134-135.
Informationscentralerna för Bottniska viken, Egentliga Östersjön & Västerhavet. 2009. Canadian waterweed (Elodea canadensis) and Nuttall's waterweed (Elodea nuttallii). Alien Species in Swedish Seas. http://www.frammandearter.se/0/2english/pdf/Elodea_canad_nuttall.pdf , Date of access: 2009-09-04
Kurtto, A., Tomminen, J., Leppäkoski, E, and Nummi, P. 2001. Alien Species in Finland, Ministry of the Environment. http://www.vyh.fi/luoso/lumo/lumonet/aliens.htm Date of access: 2001-02-01.
Larson, D. 2003. Predicting the threats to ecosystem function and economy of alien vascular plants in freshwater environments, SLU, Rapport 2003:7
Larson, D. and Willén, E. 2006. Främmande och invasionsbelägna arter i Sverige, 2006, Svensk botanisk tidskrift, 100: 5 – 15.
Larson, D. 2007. Non-indigenous freshwater plants. Patterns, processes and risk evaluation. Doctoral thesis, Department of Environmental Assessment. Swedish Agricultural University. Acta Universitatis agriculturae Sueciae 2007:15
Lehtonen, J. 2000, Vesirutto ja karvalehti täyttävät ajoittain Littoistenjärven. Aurora 1: 29-31.
Les, D.H. 1988, Breeding systems, population structure, and evolution in hydrophilous angiosperms. Annals of the Missouri Botanic Garden 75: 819-835.
Lodge, D.M. 1991. Herbivory on frehwater macrophytes. Aquatic Botany 41:195-224.
Mielecki, M. and Peiczynska, E. 2005. The influence of fragmentation on the growth of Elodea canadensis Michx. in different light conditions. Polish Journal of Ecology 53:155-164.
Mjelde, M. 2009. Smal vasspest (Elodea nuttallii) i Bjårvatn. Forekomst og dybdeutbredelse av vannvegetasjonen i 2008. Norsk institutt for vannforskning. NIVA-rapport lnr 5731-2009.
Moesland B., Löjnant, B., Mathiesen, H., Mathiesen, L., Pedersen, A., Thyssen, A., and Schou, J.C. 1990. Danske vandplanter. Miljönytt 2.
Rörslett, B., Berge, O. and Johansen, S.W. 1985. Mass invasion of Elodea canadensis in a mesotrophic, Southern Norwegian lake – impact on water quality. Verh. Int. Ver. Limnology 22:2920-2926.
Sand-Jensen, K. 2000. An introduced vascular plant – the Canadian waterweed (Elodea canadensis). In: Weidema, I. (ed.). 2000 Introduced species in the Nordic countries. NordTema 2000:13 pp. 96-100.
Spicer, K.W. and Catling, P.M. 1988. The biology of Canadian weeds, Elodea canadensis Michx. Canadian Journal of Plant Science 68: 1035-1051.

Date of creation/modification of this fact sheet: 07-02-2011