A15
Elodea canadensis community

Synonymy
Elodetum Matthews 1914, Tansley 1939; Medium-slow current vegetation Butcher 1933 *p.p.*; Pflanzengesellschaft mit *Elodea canadensis* Solinska 1963; *Elodeetum canadensis* (Pignatti 1953) Passarge 1964; *Elodea* society Spence 1964.

Constant species
Elodea canadensis.

Physiognomy
The *Elodea canadensis* community comprises species-poor vegetation in which this particular kind of North American pondweed has become dominant. The plant overwinters as short unbranched stems or as turions but, by early summer, it can become very abundant, either as free-floating masses or with the shoots rather loosely anchored in the substrate. In such stands, other species are at most only occasional, though quite a variety are represented at low frequency. Commonest among other submerged aquatics are *Ceratophyllum demersum*, *Myriophyllum spicatum*, *Potamogeton pectinatus*, *P. crispus*, *P. perfoliatus*, *Callitriche stagnalis*, *C. hamulata*, *Ranunculus circinatus* and *R. penicillatus* ssp. *pseudofluitans*. Then, there are quite often some associated mats of duckweeds *Lemna minor* and *L. gibba*, with *Potamogeton natans* and *Polygonum amphibium* forming an open canopy of floating leaves. *Glyceria fluitans* shoots sometimes trail in from water margins.

Habitat
The *Elodea canadensis* community is most characteristic of still to sluggish, nutrient-rich waters, shallow to quite deep, and generally with fine mineral beds. Since the introduction of the plant, some century and a half a go, it has become very widespread through the warmer lowlands of Britain, occurring commonly in ponds and lakes, canals, dykes and slow-moving rivers and streams. Although its overall range seems to have now stabilised, *E. canadensis* will still actively colonise new water bodies, and the community often makes an early appearance in sites like flooded gravel pits, as well as sometimes quickly returning to waters recovering from pollution.

E. canadensis is native to most of the United States and parts of Canada and was first authentically reported from Great Britain in 1842, having perhaps been introduced on imported timber. Its period of rapid spread started shortly after 1850, when it began to appear in abundance around the Fens, and within a decade it was to be found in most of southern England and parts of the Midlands, extending through nearly all of the English lowlands and into some of southern Scotland by 1880. Subsequent colonisation northwards was more sporadic and largely confined to the east during the closing years of the last century and the beginning of this and in Wales, too, penetration beyond the early stations along the borders was slow and local (Simpson 1984).

E. canadensis seems to have reached the maximum extent of its distribution by the middle of the present century (Simpson 1983, 1986) and remains strongly confined to the lowlands of Britain where more fertile and quieter waters are concentrated in regions of warmer summer climate. Most records occur in places with a mean annual maximum temperature of 24 °C or more (Conolly & Dahl 1970), but within this zone the plant rarely makes vigorous growth unless there is at least modest enrichment of the waters and it performs best in distinctly eutrophic conditions (Haslam 1978, Simpson 1983, 1986). The foliage can actually stand much battering by turbulence (Haslam 1978) but, being poorly anchored or not at all, *E. canadensis* will not persist in waters with a continuously fast flow and favours still or sluggish conditions. In the subdued landscape of the British lowlands, where the majority of the underlying rocks and superficials are readily weathered sedimentaries and open waters accumulate much fine mineral material, these requirements are widely met in both natural and artificial water bodies. Here, in lakes and pools, drainage channels, canals, streams and

rivers, stands of this vegetation can penetrate quite deeply if the waters are clear, often to well over 1 m. The substrates are usually silty but *E. canadensis* is intolerant of turbid conditions and does not thrive in shaded waters (Haslam 1978, Simpson 1986). To the north and west, suitable sites of these kinds become scarce, but the community occurs locally in more mesotrophic lakes where there is some sedimentation, usually in deeper waters, over 1 m, where wave disturbance is minimal (Spence 1964).

In the early decades of the expansion of *E. canadensis*, it became clear that invasion and rapid increase in abundance were followed fairly quickly by a decline (Simpson 1984). It might take just three or four seasons for the plant to assume the proportion of a major pest at a site, with such luxuriance being maintained for up to a decade more. Thereafter, though, the population would wane over 7–15 years, leaving just a relict, or disappearing entirely, perhaps returning a few years later. Such a local pattern has been repeated nationally, such that, at the turn of the century, populations were generally declining in the south-east and central England, while invasion was still proceeding vigorously to the north and west. It still seems to be the case that more northerly stands have an abundance not usually seen in the south, although, through the country as a whole, dramatic invasions are now rare events. *E. canadensis* can still colonise new water bodies, however, like flooded gravel pits, and Grose (1957) and Messenger (1971) have both reported the kind of rapid increase in abundance typical of the early invasions.

E. canadensis is a dioecious plant and, with but a single exception, all populations examined have been female (Simpson 1984). Reproduction is thus vegetative with us, occurring by shoot fragmentation, the stems being extremely brittle and the broken portions quickly producing adventitious roots. Expansion within lakes or along canals and rivers is thus fairly simple and perhaps encouraged by periodic disturbance by currents, spates or boat traffic. Dispersal to isolated water bodies is more problematic. Certainly, in the early days of its invasion, deliberate introduction by human agency occurred in some places, as around Cambridge (Marshall 1852), but this never seems to have happened widely and it is possible that waterfowl play an important part. Plants appear to survive for several days out of water, provided conditions remain humid, and fragments of shoots may adhere to feathers or feet (Simpson 1986).

The ability of *E. canadensis* to attain great abundance means that it can become a hazard to water flow through drainage systems and to boat traffic and, despite its reduced presence in many areas nowadays, clearance by chemical or mechanical means is still often necessary. Its power of vegetative spread enables it to recover fairly quickly where fragments are left after cutting or dredging. Moreover, although under undisturbed conditions *E. canadensis* attains peak biomass in early summer, cut shoots can make luxuriant growth at any time between spring and autumn.

Zonation and succession

The *E. canadensis* community can be found with a variety of other submerged aquatic vegetation in more nutrient-rich, standing or slow-moving waters, although where conditions are especially congenial it may overwhelm these with its luxuriant growth. Open covers of floating-leaved or floating vegetation may occur above the pondweed, and the community can persist in sparse swamp but, where colonising emergents become dense, it is shaded out.

In many lowland ponds, dykes and canals, stands of *E. canadensis* are a major element among the aquatics, sometimes the only submerged vegetation. Duckweed mats are often found in association, of the simpler kind with *Lemna gibba* or *L. minor* or, in purer waters, of the richer *Spirodela-Hydrocharis* type. In a very few places, as among some of the Broadland dykes, the *E. canadensis* community occurs in intimate association with *Hydrocharis-Stratiotes* vegetation. Stands can persist, too, beneath open canopies of the water-lily communities, the *Nymphaeetum albae* and, more commonly in richer waters, the *Nuphar lutea* vegetation, or under the *Potamogeton natans* or *Polygonum amphibium* communities, but wherever these become dense, *E. canadensis* tends to be shaded out. Quite often, in such situations, or beneath overhanging woody vegetation alongside dykes or streams or around pond margins, it is replaced by the more tolerant *Ceratophylletum demersi*.

In other places, there is a more varied submerged aquatic flora in which stands of *E. canadensis* become locally dense among richer assemblages like the *Potamogeton-M. spicatum* community of cleaner, base-rich, eutrophic waters. However, comparing past and present accounts of aquatic vegetation, it seems certain that some of the spread of *E. canadensis* has been at the expense of such communities, their diversity in composition and dominance being reduced as a result. The same trend is visible to a lesser extent in the *Potamogeton-M. alterniflorum* vegetation, though this is a community of more base-poor and less eutrophic waters, many of whose stands occur beyond the range of *E. canadensis*. Both these kinds of pondweed vegetation and related *M. alterniflorum* stands can also tolerate somewhat more fast-moving waters than the *E. canadensis* community and they persist, albeit often in attenuated forms, higher upstream than it can penetrate. The same is true of crowfoot vegetation dominated by *Ranunculus penicillatus* ssp. *pseudofluitans* and *R. fluitans*, though these can be found in patchworks with *E. canadensis* in more slow-moving reaches of streams and

rivers, the proportions of the vegetation types often varying from season to season and through any years (Butcher 1933).

E. canadensis is sometimes found growing with its more recently introduced relative *E. nuttallii*, although great abundance of the one is rarely seen among vigorous plants of the other, and it is possible that there is some kind of competitive relationship between the two. Certainly, there are cases where *E. nuttallii* has been seen actually to replace *E. canadensis* over a few years (Briggs 1977, Lund 1979), although the basis of such changes is unclear (Simpson 1984). In polluted waters, neither of these pondweeds thrives and, in the many places where effluents have drained into open waters with the *E. canadensis* community it has been replaced by *P. pectinatus* vegetation where any vascular plants at all have survived.

Many of the more fertile lowland waters favoured by *E. canadensis* are very prone to marginal invasion of swamp plants, and stands are sometimes found among open covers, the *Scirpetum lacustris*, the *Typhetum latifoliae* or Glycerio-Sparganion water-margin vegetation, but any more than light shade is inimical to the pondweed.

Distribution

The *E. canadensis* community is widespread through the lowlands of Britain, though rarely abundant now, particularly in the south of the country.

Affinities

Dense stands of *E. canadensis* were early recognised as an important component in more fertile aquatic systems (Matthews 1914, Butcher 1933, Tansley 1939) and have also been recorded from the Continent, through most of which the plant is a commonly encountered adventive (Pignatti 1953, Solinska 1963, Passarge 1964). The most obvious location for such vegetation is among the Parvopotamion.

Floristic table A15

Elodea canadensis	V (5–10)
Ceratophyllum demersum	II (2–4)
Lemna minor	II (3–7)
Potamogeton natans	II (1–4)
Myriophyllum spicatum	I (2–3)
Potamogeton pectinatus	I (1–4)
Potamogeton crispus	I (4–6)
Callitriche stagnalis	I (2)
Lemna trisulca	I (2–3)
Glyceria fluitans	I (1–6)
Ranunculus circinatus	I (4)
Potamogeton perfoliatus	I (4)
Ranunculus penicillatus pseudofluitans	I (5)
Callitriche hamulata	I (4)
Polygonum amphibium	I (2)
Spirodela polyrhiza	I (2)
Lemna gibba	I (4)
Potamogeton lucens	I (2)
Nuphar lutea	I (4)
Sparganium emersum	I (5)
Nymphaea alba	I (5)
Number of samples	33
Number of species/sample	2 (1–7)

https://doi.org/10.1017/9781107340817.019 Published online by Cambridge University Press

Elodea nuttallii in aquatic vegetation

Elodea nuttallii, like *E. canadensis*, is an introduction from North America, though it was a much later arrival here, being first noted in Great Britain only in 1966. Within a decade, however, it had been recorded in ten vice-counties and, by the early 1980s, in 41 (Simpson 1984). Its spread seems to have been most vigorous in south-east and north-west England and, in some places, populations appear to remain very isolated, but the present distribution may at least partly reflect the pattern of accurate recording (Simpson 1984, 1986). For this is a plant that shows great phenotypic plasticity, with extremes of variation that look more different from one another at first sight, than do some forms from *E. canadensis*. In fact, although *E. canadensis* is itself quite variable in its morphology, there are consistent differences between the two taxa in leaf shape and size, and in Britain there is no question of hybridisation between them (Simpson 1988, Rich & Rich 1988).

Extensive and luxuriant stands of *E. nuttallii* certainly occur (Simpson 1984), but there are insufficient data to be able to define a distinct vegetation with it as sole dominant, or indeed to say very much about its ecological preferences. It has been recorded in the available samples in a variety of communities, notably in the *Ceratophylletum demersi* and among the *Potamogeton-M. spicatum* vegetation, in standing or sluggish, eutrophic waters, in the latter case distinctly base-rich. Like *E. canadensis*, it may be able to invade and increase among the more species-rich pondweed assemblages, overwhelming their diversity, although there is some evidence that it is one or the other *Elodea* spp. that gains eventual prominence, rather than both together. In general, however, the two seem to have similar ecological requirements, though the limited geographical range of *E. nuttallii* means that it is nothing like so widespread yet among, for example, the more mesophytic *Potamogeton-M. alterniflorum* vegetation of the north and west.

E. nuttallii is local but rapidly increasingly elsewhere in western Europe (Wolff 1980) where, like *E. canadensis*, it is regarded as a character species of the Parvopotamion.