

- 1 **ESM 1** List of references from the query used in the analyses with additional information on types and names of freshwater systems with reported nuisance vegetation
- 2 (n=81). For full references see ESM 4.

Reference	Problems reported in:	Name(s) of reported ecosystem(s) with problems:	Country / region
Abernethy et al. 1996	range of freshwater systems	Not specified (lab experiment)	Europe
Aguar and Ferreira 2013	lakes and waterways	Not specified	Iberian Peninsula / Portugal
Akhurst et al. 2012	lakes	Emigrant Creek Dam reservoir	Australia
Albright and Ode 2011	lakes	Lake Sharpe (South Dakota; US)	North America
Alwin et al. 2010	lakes and waterways	Lake Ovid, Michigan	USA
Anderson 2003	not specified: lakes and waterways in general	Examples: Olympic water-sports venue Australia; Lake Tahoe, US; Sacramento-San Joaquin Delta, US	Mainly USA & Australia
Bacchus and Barile 2005	lakes and waterways	Alexander, Wakulla, Juniper & Peacock Springs, Bulow Creek & Orange Cove, Florida	USA
Bailey and Calhoun 2008	lakes	8 lakes in Maine	USA
Berger et al. 2015	lakes and waterways	Not specified	USA
Bickel and Closs 2009	mainly lakes	Experiment in Lake Dunstan	New Zealand
Bickel and Schooler 2015	not specified, but anyways lakes	3 lakes in South-East Queensland (Lake Macdonald; Ewen Maddock Dam; Seibs Dam)	Australia
Brandrud and Roelofs 1995	mainly lakes (also general waterways)	55 lakes S and SW Norway	Norway
Brandrud 2002	lakes	SW Norway (and lit. example for Netherlands)	Norway
Burlakova and Karatayev 2007	lakes and waterways	Lake Lamar and lake Neff in Texas	USA
Cabrera-Walsh et al. 2011	lakes	Experiments in: Iberá Lake, Argentina. Mentioned from lit. in US, Australia, Japan, SE-Asia, New Guinea, China, India, Europe and S Africa.	Argentina
Caffrey et al. 2010	lakes	Lough Corrib	Ireland
Carr et al. 2003	waterways	28 rivers Ontario	Canada
Cason and Roost 2011	lakes	Wisconsin lakes	USA
Charudattan 2001	not specified: lakes and waterways in general	Examples: Brazilian hydropower reservoirs; several lakes in the US.	World (focus on USA)
Clayton and Champion 2006	lakes	Mainly Waikato hydro-lakes, New Zealand	New Zealand
Coetzee et al. 2011	lakes	Not specified	South Africa
Cruz et al. 2015	lakes and waterways	Hydroelectric reservoirs (e.g. Jupia reservoir, Brazil)	Brazil
David et al. 2006	not specified	Not specified (experiments in Sacramento-San Joaquin River Delta, California)	USA
Evans and Wilkie 2010	not specified	Aquatic systems in South-East US	USA
Everitt et al. 1999	mainly waterway (and some lakes)	Waterways and lakes South Texas	USA
Finlay and Vogt 2016	lakes	Loch Leven	Canada
Fulmer and Robinson 2008	lakes	38 reservoirs in Arizona, US	USA
Garbey et al. 2003	waterways	Experiments in Vosges mountain streams	France
Godfrey et al. 1994	lakes	Infested pond near Mountain Ranch, California	USA
Goodenberger and Klaiber 2016	lakes	Seven county region, Minnesota	USA
Gu 2006	lakes	Florida lakes in general, US	USA
Harman et al. 2005	lakes	Lake Moraine and Hatch Lake, New York	USA
Hilt et al. 2006	lakes	Many examples in Brandenburg, Bavaria, Baden-Wuerttemberg, Lower Saxony, N Rhine-Westphalia, Saxony and Saxony-Anhalt area.	Germany
Hofstra et al. 2006	lakes and waterways	North Island and northern South Island. Fieldtest in Kaituna Wildlife Management Reserve.	New Zealand
Hogsdon et al. 2007	not specified, lakes and waterways mentioned	Not specified (Experiments in lake Kasshabog, Ontario)	Canada
Jones and Cooke 1984	lakes	Lake Rockwell, Ohio	USA
Lucassen et al. 2016	lakes	Softwater lakes in southern Norway	Europe (focus on Norway)

- 3 **ESM 1 (continued)** List of references from the query used in the analyses with additional information on types and names of freshwater systems with reported nuisance
4 vegetation (n=81). For full references see ESM 4.

Reference	Problems reported in:	Name(s) of reported ecosystem(s) with problems:	Country / region
Madsen 1993	not specified, lakes and waterways mentioned	Many examples: Lake George, Buckhorn Lake; East Twin Lakes (OH); Badfish Creek; Lilly Lake (WI); Little Lake Barton.	USA
Madsen 1998	not specified	Not specified	USA
Madsen et al. 2016	lakes	Detroit Lakes	USA
Mallin et al. 2016	lakes	Greenfield Lake	USA
Mangan and Baars 2013	not specified	Not specified	Ireland, UK and parts of mainland Europe
Mataraza et al. 1999	waterways	Kings Bay, Florida	USA
McKee et al. 2002	not specified	Not specified	UK
Michelan et al. 2014	lakes and waterways	Not specified	Brazil
Mitchell 1996	not specified	Not specified	Australia
Moe et al. 2013	lakes (rivers also mentioned)	153 lakes in Southern Norway	Norway
Nawrocki et al. 2016	lakes	Shearon Harris Lake, Tar River Reservoir, Lake Tillery, Lake Gaston (North Carolina)	USA
Nelson et al. 2002	lakes and waterways	Not specified (lab experiment)	USA
Newman et al. 1996	not specified (most examples are from lakes)	North America	USA
Nichols and Shaw 1986	not specified, lakes and waterways mentioned	Not specified	World (especially NE of USA)
Nichols 1991	not specified	Not specified	not specified
Nilsson and Brittain 1996	waterways	Not specified (rivers in boreal and temperate region)	not specified
Poirrier et al. 2010	lakes and waterways	Lakes, canals, bayous, and ponds in the Jean Lafitte National Historical Park and Preserve, Louisiana	USA
Quilliam et al. 2015	lakes	Not specified	not specified
Reeves et al. 2008	lakes	29 lakes in Michigan & 1 in Wisconsin	USA
Richardson 2008	not specified, general review, most examples are on (big) lakes	Not specified	USA
Richter and Gross 2013	lakes	Not specified (mesocosm study)	Germany
Santos et al. 2009	waterways	Sacramento-San Joaquin River Delta, California, US	USA
Schneider et al. 2013	lakes and waterways	Lakes and rivers South of Norway	Norway
Schoonbee 1991	lakes and waterways	Lake Germiston and Lake Florida	South Africa
Schwarz and Howard-Williams 1993	lakes	Lake Taupo and Rotorua	New Zealand
Sisneros et al. 1998	Waterways	Not specified, Western US (Tests in canals in Idaho and Colorado)	USA
Slade et al. 2008	lakes and waterways	Not specified	not specified (USA lab. study)
Spencer and Ksander 1999	not specified	Not specified (experiments performed in Oregon House Canal, California, US)	USA
Sprecher et al. 1998	not specified, but anyways waterways	Not specified, Western US	USA
Stalling et al., 2015	not specified	Southeastern US	USA
Sukhodolov and Sukhodolova 2010	waterways	Not specified	not specified
Suren 2009	waterways	Urban streams in Christchurch, New Zealand	New Zealand
Tamayo and Olden 2014	lakes	319 lakes, Washington state	USA
Trebitz et al. 1993	lakes	Lake Wingra (Wisconsin)	USA
Van Nes et al. 1999	lakes	Not specified	not specified
Van Nes et al. 2002	lakes	Not specified	not specified

- 5 **ESM 1 (continued)** List of references from the query used in the analyses with additional information on types and names of freshwater systems with reported nuisance
- 6 vegetation (n=81). For full references see ESM 4.

Reference	Problems reported in:	Name(s) of reported ecosystem(s) with problems:	Country / region
Washington et al. 1992	lakes	Not specified	not specified
Wells et al. 2003	waterways	Rangiriri and Churchill East drains, New Zealand	New Zealand
Wersal and Madsen 2011a	lakes and waterways	Not specified	USA
Wersal and Madsen 2011b	lakes and waterways	Not specified	USA
Yakandawala and Dissanayake 2010	not specified	Not specified	Sri Lanka
Yeo and McHenry 1977	lakes and waterways	Example given: Lake Ellis, California	USA
Zefferman 2014	waterways	Not specified (experiments performed in artificial streams, California, US)	not specified
Zefferman and Harris 2016	waterways	Putah Creek	USA

ESM 2 Summary of the main ecosystem services of the freshwater ecosystem where nuisance aquatic plants cause problems as stated in scientific literature. Number between square brackets indicates number of references. For full references see ESM 4.

Main services categorized	Category description	References
<i>Boat traffic</i>	Impairment of physical movement of a boat or ship through the water by macrophytes, both recreational and commercial in nature.	[32] Aguiar and Ferreira 2013; Alwin et al. 2010; Anderson 2003; Bacchus and Barile 2005; Bailey and Calhoun 2008; Bickel and Closs 2009; Caffrey et al. 2010; Cason and Roost 2011; Charudattan 2001; David et al. 2006; Evans and Wilkie 2010; Everitt et al. 1999; Finlay and Vogt 2016; Fulmer and Robinson 2008; Goodenberger and Klaiber 2016; Gu 2006; Hilt et al. 2006; Hogsden et al. 2007; Jones and Cooke 1984; Madsen 1993; Madsen 1998; Mataraza et al. 1999; Newman et al. 1996; Reeves et al. 2008; Richardson 2008; Santos et al. 2009; Schoonbee 1991; Stalling et al. 2015; Tamayo and Olden 2014; Van Nes et al. 2002; Van Nes et al. 1999; Washington et al. 1992.
<i>Fishing</i>	All problems created by macrophytes which hamper recreational or commercial fishing activities.	[18] Aguiar and Ferreira 2013; Albright and Ode 2011; Alwin et al. 2010; Anderson 2003; Bacchus and Barile 2005; Bickel and Closs 2009; Caffrey et al. 2010; Charudattan 2001; Cruz et al. 2015; Fulmer and Robinson 2008; Jones and Cooke 1984; Madsen 1993; Reeves et al. 2008; Richardson 2008; Schoonbee 1991; Stalling et al. 2015; Tamayo and Olden 2014; Van Nes et al. 1999.
<i>Swimming</i>	All problems created by macrophytes which lead to less people entering the water for the purpose of (recreational) swimming.	[17] Alwin et al. 2010; Bacchus and Barile 2005; Bailey and Calhoun 2008; Bickel and Closs 2009; Caffrey et al. 2010; Cason and Roost 2011; Finlay and Vogt 2016; Fulmer and Robinson 2008; Goodenberger and Klaiber 2016; Hilt et al. 2006; Jones and Cooke 1984; Madsen 1993; Reeves et al. 2008; Stalling et al. 2015; Tamayo and Olden 2014; Van Nes et al. 2002; Van Nes et al. 1999.
<i>Hydrodynamics</i>	All problems caused by macrophytes which lead to problematic reduction in water flow or discharge capacity in waterways, but also congestion of water bodies and clogging of (industrial) intake pipes.	[34] Aguiar and Ferreira 2013; Anderson 2003; Berger et al. 2015; Bickel and Closs 2009; Burlakova and Karatayev 2007; Carr et al. 2003; Cason and Roost 2011; Charudattan 2001; Clayton and Champion 2006; David et al. 2006; Evans and Wilkie 2010; Everitt et al. 1999; Garbey et al. 2003; Gu 2006; Hilt et al. 2006; Hofstra et al. 2006; Hogsden et al. 2007; Madsen 1993; Madsen 1998; Newman et al. 1996; Richardson 2008; Santos et al. 2009; Schoonbee 1991; Schwarz and Howard-Williams 1993; Sisneros et al. 1998; Slade et al. 2008; Sprecher et al. 1998; Stalling et al. 2015; Sukhodolov and Sukhodolova 2010; Van Nes et al. 1999; Washington et al. 1992; Wells et al. 2003; Zefferman 2014; Zefferman & Harris 2016.
<i>Other (Including 'Ecological')</i>	All others, ranging from decreased aesthetics and waterfront property value to increased sedimentation and altering nutrient cycling of the system. All (biotic) problems created by nuisance macrophytes which concern changes in biodiversity, in the vegetation, biotic communities, available habitat for other species and damage to the ecosystem in general. Irrespective of whether this impairs human activities or not.	[47] Aguiar and Ferreira 2013; Albright and Ode 2011; Alwin et al. 2010; Anderson 2003; Bailey and Calhoun 2008; Berger et al. 2015; Bickel and Closs 2009; Brandrud 2002; Burlakova and Karatayev 2007; Caffrey et al. 2010; Cason and Roost 2011; Charudattan 2001; Clayton and Champion 2006; Cruz et al. 2015; David et al. 2006; Evans and Wilkie 2010; Everitt et al. 1999; Fulmer and Robinson 2008; Garbey et al. 2003; Goodenberger and Klaiber 2016; Gu 2006; Harman et al. 2005; Hogsden et al. 2007; Madsen 1993; Madsen 1998; Mallin et al. 2016; Mangan and Baars 2013; Mataraza et al. 1999; Michelin et al. 2014; Nelson et al. 2002; Nichols and Shaw 1986; Nichols 1991; Poirrier et al. 2010; Reeves et al. 2008; Richardson 2008; Santos et al. 2009; Stalling et al. 2015; Suren 2009; Tamayo and Olden 2014; Trebitz et al. 1993; Washington et al. 1992; Wersal and Madsen 2011a and b; Yakandawala and Dissanayake 2010; Yeo and McHenry 1977; Zefferman 2014; Zefferman & Harris 2016.

ESM 3 Summary of vegetation characteristics used in scientific literature to describe/classify nuisance vegetation. Combinations of categories have been used in references. Number between square brackets indicates number of references. For full references see ESM 4.

Main description class	Descriptions included in main class	References
<i>High growth rate</i>	Macrophytes exhibit nuisance growth when they grow rapidly, aggressively or any other growth rate related expression.	[4] Brandrud and Roelofs 1995; Caffrey et al. 2010; Charudattan 2001; Reeves et al. 2008.
<i>High height</i>	Nuisance macrophytes are species that form surface canopies, grow to the surface (i.e. canopy depth = 0 m), form tall stands or emerge from the water column.	[24] Alwin et al. 2010; Berger et al. 2015; Brandrud and Roelofs 1995; Brandrud 2002; Caffrey et al. 2010; Cason and Roost 2011; Clayton and Champion 2006; Goodenberger and Klaiher 2016; Harman et al. 2005; Hilt et al. 2006; Lucassen et al. 2016; Madsen 1993; Moe et al. 2013; Newman et al. 1996; Poirrier et al. 2010; Richter and Gross 2013; Schwarz and Howard-Williams 1993; Sisneros et al. 1998; Tamayo and Olden 2014; Van Nes et al. 2002; Washington et al. 1992; Wersal and Madsen 2011a; Yeo and McHenry 1977; Zefferman & Harris 2016.
<i>High coverage</i>	Nuisance vegetation consists of macrophytes that: ‘completely cover a water body’, ‘cover large expanses’, ‘grow extensively’, forms dense beds or dense stands and similar descriptions.	[45] Albright and Ode 2011; Alwin et al. 2010; Bacchus and Barile 2005; Bailey and Calhoun 2008; Berger et al. 2015; Brandrud and Roelofs 1995; Brandrud 2002; Burlakova and Karatayev 2007; Cabrera-Walsh et al. 2011; Caffrey et al. 2010; Cason and Roost 2011; Charudattan 2001; Clayton and Champion 2006; Cruz et al. 2015; David et al. 2006; Evans and Wilkie 2010; Finlay and Vogt 2016; Fulmer and Robinson 2008; Gu 2006; Hilt et al. 2006; Hogsden et al. 2007; Jones and Cooke 1984; Lucassen et al. 2016; Madsen 1998; Mangan and Baars 2013; Mataraza et al. 1999; Moe et al. 2013; Nawrocki et al. 2016; Nelson et al. 2002; Newman et al. 1996; Nichols 1991; Poirrier et al. 2010; Reeves et al. 2008; Richardson 2008; Schneider et al. 2013; Schoonbee 1991; Schwarz and Howard-Williams 1993; Sprecher et al. 1998; Stalling et al. 2015; Suren 2009; Tamayo and Olden 2014; Trebitz et al. 1993; Van Nes et al. 1999; Washington et al. 1992; Yeo and McHenry 1977.
<i>Forms (near) monospecific vegetation</i>	Descriptions stating that nuisance plants form (almost) monospecific vegetation by either replacing or dominating the local plant community.	[9] Cabrera-Walsh et al. 2011; Charudattan 2001; Fulmer and Robinson 2008; Hogsden et al. 2007; Madsen 1998; Mangan and Baars 2013; Nelson et al. 2002; Schneider et al. 2013; Tamayo and Olden 2014.
<i>High biomass</i>	Descriptions stating that nuisance macrophytes form: ‘too much biomass’ or ‘excessive biomass’.	[12] Akhurst et al. 2012; Carr et al. 2003; Clayton and Champion 2006; Fulmer and Robinson 2008; Lucassen et al. 2016; Madsen 1993; Newman et al. 1996; Nilsson and Brittain 1996; Quilliam et al. 2015; Suren 2009; Wells et al. 2003; Zefferman & Harris 2016.
<i>Other</i>	I.e. where no real measurable plant trait was mentioned, think of: Macrophytes were a described as nuisance if they: ‘caused problems’; ‘caused (serious) nuisance’; ‘became noxious’; ‘were found in problematic quantities’; ‘are (legally) classified as a noxious weed’; ‘forms nuisance growth’; were locally very abundant or if there is ‘a nuisance infestation of macrophytes’.	[49] Abernethy et al. 1996; Aguiar and Ferreira 2013; Akhurst et al. 2012; Anderson 2003; Bacchus and Barile 2005; Bickel and Closs 2009; Bickel and Schooler 2015; Brandrud and Roelofs 1995; Brandrud 2002; Charudattan 2001; Coetzee et al. 2011; Cruz et al. 2015; David et al. 2006; Evans and Wilkie 2010; Everitt et al. 1999; Garbey et al. 2003; Godfrey et al. 1994; Gu 2006; Harman et al. 2005; Hilt et al. 2006; Hofstra et al. 2006; Hogsden et al. 2007; Madsen 1998; Madsen et al. 2016; Mallin et al. 2016; McKee et al. 2002; Michelan et al. 2014; Mitchell 1996; Nelson et al. 2002; Nichols and Shaw 1986; Nichols 1991; Nilsson and Brittain 1996; Poirrier et al. 2010; Reeves et al. 2008; Richardson 2008; Richter and Gross 2013; Schneider et al. 2013; Schoonbee 1991; Slade et al. 2008; Sprecher et al. 1998; Stalling et al. 2015; Sukhodolov and Sukhodolova 2010; Suren 2009; Tamayo and Olden 2014; Washington et al. 1992; Wersal and Madsen 2011b; Yakandawala and Dissanayake 2010; Zefferman 2014; Zefferman & Harris 2016.

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