NEW YORK
NON-NATIVE PLANT INVASIVENESS RANKING FORM

Scientific name:	Butomus umbellatus L. USDA Plants Code: BUUM
Common names:	flowering-rush
Native distribution:	Eurasia (Europe, Asia) and Africa
Date assessed:	June 5, 2012
Assessors:	Steven D. Glenn
Reviewers:	LIISMA SRC
Date Approved:	14 August 2012 Form version date: 29 April 2011

New York Invasiveness Rank: Moderate (Relative Maximum Score 50.00-69.99)

Distribution and Invasiveness Rank (*Obtain from PRISM invasiveness ranking form*)			
	Status of this species in each PRISM:	Current Distribution	PRISM Invasiveness Rank
1	Adirondack Park Invasive Program	Not Assessed	Not Assessed
2	Capital/Mohawk	Not Assessed	Not Assessed
3	Catskill Regional Invasive Species Partnership	Not Assessed	Not Assessed
4	Finger Lakes	Not Assessed	Not Assessed
5	Long Island Invasive Species Management Area	Not Present	Insignificant
6	Lower Hudson	Not Assessed	Not Assessed
7	Saint Lawrence/Eastern Lake Ontario	Not Assessed	Not Assessed
8	Western New York	Not Assessed	Not Assessed

Invasiveness Ranking Summary (see details under appropriate sub-section)		Total (Total Answered*) Possible	Total
1	Ecological impact	40 (20)	6
2	Biological characteristic and dispersal ability	25 (25)	18
3	Ecological amplitude and distribution	25 (25)	19
4	Difficulty of control	10 (10)	8
	Outcome score	100 (80)[b]	51[a]
	Relative maximum score †		63.75
	New York Invasiveness Rank §	Moderate (Relative Maximum Score 50.00-69.99)	

* For questions answered “unknown” do not include point value in “Total Answered Points Possible.” If “Total Answered Points Possible” is less than 70.00 points, then the overall invasive rank should be listed as “Unknown.”
†Calculated as 100(a/b) to two decimal places.
§Very High >80.00; High 70.00−80.00; Moderate 50.00−69.99; Low 40.00−49.99; Insignificant <40.00
Not Assessable: not persistent in NY, or not found outside of cultivation.

A. DISTRIBUTION (KNOWN/POTENTIAL): Summarized from individual PRISM forms

A1.1. Has this species been documented to persist without cultivation in NY? (reliable source; voucher not required)	
☒	Yes – continue to A1.2
☐	No – continue to A2.1
A1.2. In which PRISMs is it known (see inset map)?	
☒	Adirondack Park Invasive Program
☒	Capital/Mohawk
☐	Catskill Regional Invasive Species Partnership
☒	Finger Lakes
☐	Long Island Invasive Species Management Area
☐	Lower Hudson
☒	Saint Lawrence/Eastern Lake Ontario
☐	Western New York

Documentation: Reported from several upstate NY counties and the Hudson River Basin.
Sources of information:
Marsden & Hauser, 2009; Mills, et al., 1996; Weldy & Werier, 2012.

A2.1. What is the likelihood that this species will occur and persist outside of cultivation, given the climate in the following PRISMs? (obtain from PRISM invasiveness ranking form)

Not Assessed	Adirondack Park Invasive Program
Not Assessed	Capital/Mohawk
Not Assessed	Catskill Regional Invasive Species Partnership
Not Assessed	Finger Lakes
Unlikely	Long Island Invasive Species Management Area
Not Assessed	Lower Hudson
Not Assessed	Saint Lawrence/Eastern Lake Ontario
Not Assessed	Western New York

Documentation: This species is certainly cold hardy enough to survive in LISSMA based on home and North American infestation ranges (Anderson, et al., 1974; Haynes, 2000; Weldy & Werier, 2012. Been in NYS since 1929 and has not expanded south of Schenectady.

On possible limiting factor could be pH. Little was found in the literature regarding pH ecology and Butomus, except one web site anecdotally stated "plant prefers acid, neutral and basic (alkaline) soils." In sites where pH is known water is neutral to alkaline.

A survey of some of the documented sites of infestation in North America reveals the following:

Cayuga Lake- pH approximately 8 (Nitzova, I. 2010)
Lake Champlain – 1992-2011, various localities pH 7-9 (Anonymous, 2012)
St. Lawrence River – data from 1950-1980, various localities, pH 7.2-7.8 (Ramesh, 1989).
Lake Erie - close to pH 8.4 year-around, as high as 8.9, (but under the thermocline, during anoxia, pH in the 7 and upper 6 range) (Anonymous, 2012b).

While a survey of Long Island and Staten Island references regarding pH reveals the following:

Peconic River – between 1990-1993 from several sites – pH 4.5 -6.6 (Schoonen & Brown, no date)
Carmens River – several locations pH 6.6-7.2 (Winslow, et al. 2008)

For Nassau County soils- a survey of all soil types under table 15, "Physical and chemical properties of soils" finds that out of 26 soil types with a pH rating, 23 range in pH from 3.6-6, with only 3 soil types ranging in pH to 7.8 (Wulforst, 1987).

For Suffolk County soils- a survey of all soil types under table 5, "Estimated engineering properties of soils" finds that out of 18 soil series with a pH rating, all range 4.5 to 6.0 (Warner, et al., 1975).

For Richmond County soils- the one area referenced on Staten Island exhibited pHs ranging from 5-6.4. Hernandez & Galbraith, 1997).

More research into the pH ranges of Butomus in its native Eurasian range may provide better insight regarding its water chemistry requirements and could change this species likelihood of occurrence from moderately likely to unlikely.

Sources of information (e.g.: distribution models, literature, expert opinions):
Anderson, et al., 1974; Anonymous, 2012; Anonymous, 2012b; George Safford Torrey Herbarium (CONN), 2012; Haynes, 2000; Hernandez & Galbraith, 1997; Nitzova, 2010; Ramesh, 1989; Schoonen & Brown, no date; Warner, , et al. 1975; Weldy & Werier, 2012; Winslow, et al., 2008; Wulforst, 1987.

If the species does not occur and is not likely to occur in any of the PRISMs, then stop here as there is no need to assess the species. Rank is "Not Assessable."

A2.2. What is the current distribution of the species in each PRISM? (obtain rank *from PRISM invasiveness ranking forms*)

	Distribution
Adirondack Park Invasive Program	Not Assessed
Capital/Mohawk	Not Assessed
Catskill Regional Invasive Species Partnership	Not Assessed
Finger Lakes	Not Assessed
Long Island Invasive Species Management Area	Not Present
Lower Hudson	Not Assessed
Saint Lawrence/Eastern Lake Ontario	Not Assessed
Western New York	Not Assessed

Documentation:
Sources of information:
Brooklyn Botanic Garden, 2012; Weldy & Werier, 2012.

A2.3. Describe the potential or known suitable habitats within New York. Natural habitats include all habitats not under active human management. Managed habitats are indicated with an asterisk.

Aquatic Habitats	Wetland Habitats	Upland Habitats
☐ Salt/brackish waters	☐ Salt/brackish marshes	☐ Cultivated*
☐ Freshwater tidal	☒ Freshwater marshes	☐ Grasslands/old fields
☒ Rivers/streams	☐ Peatlands	☐ Shrublands
☒ Natural lakes and ponds	☐ Shrub swamps	☐ Forests/woodlands
☐ Vernal pools	☐ Forested wetlands/riparian	☐ Alpine
☐ Reservoirs/impoundments*	☒ Ditches*	☐ Roadsides*
	☐ Beaches and/or coastal dunes	

Other potential or known suitable habitats within New York:

Documentation: Canal; "It is intolerant of salt or brackish water" (IPANE, 2012)
Sources of information:
Haynes, 2000; IPANE, 2012; Marsden & Hauser, 2009; Roberts, 1972; Weldy & Werier, 2012; Witmer, 1964.

B. INVASIVENESS RANKING

Questions apply to areas similar in climate and habitats to New York unless specified otherwise.

1. ECOLOGICAL IMPACT

1.1. Impact on Natural Ecosystem Processes and System-Wide Parameters (e.g. fire regime, geomorphological changes (erosion, sedimentation rates), hydrologic regime, nutrient and mineral dynamics, light availability, salinity, pH)

A. No perceivable impact on ecosystem processes based on research studies, or the absence of impact information if a species is widespread (>10 occurrences in minimally managed areas), has been well-studied (>10 reports/publications), and has been present in the northeast for >100 years. 0

B. Influences ecosystem processes to a minor degree (e.g., has a perceivable but mild influence on soil nutrient availability) 3

C. Significant alteration of ecosystem processes (e.g., increases sedimentation rates along streams or coastlines, reduces open water that are important to waterfowl) 7

D. Major, possibly irreversible, alteration or disruption of ecosystem processes (e.g., the species alters geomorphology and/or hydrology, affects fire frequency, alters soil pH, or fixes substantial levels of nitrogen in the soil making soil unlikely to support certain native plants or more likely to favor non-native species) 10
U. Unknown

Score U

Documentation:
Identify ecosystem processes impacted (or if applicable, justify choosing answer A in the absence of impact information)
One study found a small British stream tending to "stagnate" when large stretches became choked with Butomus (Hynes, 1950).
Sources of information:
Hynes, 1950.

1.2. Impact on Natural Community Structure

A. No perceived impact; establishes in an existing layer without influencing its structure 0
B. Influences structure in one layer (e.g., changes the density of one layer) 3
C. Significant impact in at least one layer (e.g., creation of a new layer or elimination of an existing layer) 7
D. Major alteration of structure (e.g., covers canopy, eradicating most or all layers below) 10
U. Unknown

Score 3

Documentation:
Identify type of impact or alteration:
Forms dense stands
Sources of information:
IPANE, 2012; Killeffer, 2004; Marsden & Hauser, 2009; NYFA

1.3. Impact on Natural Community Composition

A. No perceived impact; causes no apparent change in native populations 0
B. Influences community composition (e.g., reduces the number of individuals in one or more native species in the community) 3
C. Significantly alters community composition (e.g., produces a significant reduction in the population size of one or more native species in the community) 7
D. Causes major alteration in community composition (e.g., results in the extirpation of one or several native species, reducing biodiversity or change the community composition towards species exotic to the natural community) 10
U. Unknown

Score 3

Documentation:
Identify type of impact or alteration:
Reported to form dense stands which may displace native species.
Sources of information:
IPANE, 2012; Killeffer, 2004; Marsden & Hauser, 2009

1.4. Impact on other species or species groups (cumulative impact of this species on the animals, fungi, microbes, and other organisms in the community it invades. Examples include reduction in nesting/foraging sites; reduction in habitat connectivity; injurious components such as spines, thorns, burrs, toxins; suppresses soil/sediment microflora; interferes with native pollinators and/or pollination of a native species; hybridizes with a native species; hosts a non-native disease which impacts a native species)

A. Negligible perceived impact 0
B. Minor impact 3

C.	Moderate impact	7
D.	Severe impact on other species or species groups	10
U.	Unknown	

Score: U

Documentation:
Identify type of impact or alteration:
No references regarding impact on other species could be located.
Sources of information:

Total Possible: 20
Section One Total: 6

2. BIOLOGICAL CHARACTERISTICS AND DISPERSAL ABILITY

2.1. Mode and rate of reproduction

A.	No reproduction by seeds or vegetative propagules (i.e. plant sterile with no sexual or asexual reproduction).	0
B.	Limited reproduction (fewer than 10 viable seeds per plant AND no vegetative reproduction; if viability is not known, then maximum seed production is less than 100 seeds per plant and no vegetative reproduction)	1
C.	Moderate reproduction (fewer than 100 viable seeds per plant – if viability is not known, then maximum seed production is less than 1000 seeds per plant - OR limited successful vegetative spread documented)	2
D.	Abundant reproduction (more than 100 viable seeds per plant – if viability is not known, then maximum seed production reported to be greater than 1000 seeds per plant OR vegetative asexual spread documented as one of the plants prime reproductive means)	4
U.	Unknown	

Score: 4

Documentation:
Describe key reproductive characteristics (including seeds per plant):
One study found introduced populations in North America to be high fertile and self-compatible, with 17 of 19 populations producing 200+ seed per fruit with an average of 6100+ seeds per umbel (Eckert, et al., 2000). One British reference stated an average of 35, 000 seeds per plant (Salisbury, 1942). Another British reference states that plants were obtained bearing almost 500 fruits and estimated to contain about 258000 seeds (Salisbury, 1976).

There is no cessation of inflorescence formation until the leaves of the current year's growth are killed by frost (Lieu, 1979).

Some populations reportedly often do not flower, as in Connecticut (IPANE, 2012) or produce infertile seed as in Minnesota (Killeffer, 2004). This extreme variation in sexual fertility may be due to two distinct cytotypes (diploid & triploid) of Butomus colonizing North America (Lui, et al., 2005).

One European study stated that abundance of flowering was influenced by water depth, bottom soil properties and age and physical conditions of plants; but no specifics were cited in the abstract (Lukina & Papchenkov, 1999).

Corm-like bulbils are also formed from axillary buds which are easily detached from and germinate the following spring, forming small individual plants (Lieu, 1979).

One study (Hroudova, 1989) found this species has a "great ability" to reproduce vegetatevely by rhizome fragments.

Sources of information:
Eckert, et al., 2000; Hroudova, 1989; IPANE, 2012; Killeffer, 2004; Lieu, 1979; Lui, et al.,

2005; Lukina & Papchenkov, 1999; Salisbury, 1942;Salisbury, 1976 .

2.2. Innate potential for long-distance dispersal (e.g. bird dispersal, sticks to animal hair, buoyant fruits, pappus for wind-dispersal)

A.	Does not occur (no long-distance dispersal mechanisms)	0
B.	Infrequent or inefficient long-distance dispersal (occurs occasionally despite lack of adaptations)	1
C.	Moderate opportunities for long-distance dispersal (adaptations exist for long-distance dispersal, but studies report that 95% of seeds land within 100 meters of the parent plant)	2
D.	Numerous opportunities for long-distance dispersal (adaptations exist for long-distance dispersal and evidence that many seeds disperse greater than 100 meters from the parent plant)	4
U.	Unknown	

Score: 4

Documentation:
Identify dispersal mechanisms:
Hydrochory & Aenomochory- Salisbury (1976) states that the seeds are wind and water dispersed (also IPANE, 2012).
Muskrats may use parts of the plant to build houses and probably contribute to its local spread (Killeffer, 2004).

Sources of information:
IPANE, 2012; Killeffer, 2004; Salisbury, 1976.

2.3. Potential to be spread by human activities (both directly and indirectly – possible mechanisms include: commercial sales, use as forage/revegetation, spread along highways, transport on boats, contaminated compost, land and vegetation management equipment such as mowers and excavators, etc.)

A.	Does not occur	0
B.	Low (human dispersal to new areas occurs almost exclusively by direct means and is infrequent or inefficient)	1
C.	Moderate (human dispersal to new areas occurs by direct and indirect means to a moderate extent)	2
D.	High (opportunities for human dispersal to new areas by direct and indirect means are numerous, frequent, and successful)	3
U.	Unknown	

Score: 2

Documentation:
Identify dispersal mechanisms:
Reported to have been transported by ships ballast (Marsden & Hauser, 2009).
Sold as an ornamental but not common, one Minnesota survey of nurserymen found only 20% could identify Butomus as an invasive aquatic species (Peters, et al., 2006).

Sources of information:
Marsden & Hauser, 2009; Peters, et al., 2006.

2.4. Characteristics that increase competitive advantage, such as shade tolerance, ability to grow on infertile soils, perennial habit, fast growth, nitrogen fixation, allelopathy, etc.

A.	Possesses no characteristics that increase competitive advantage	0
B.	Possesses one characteristic that increases competitive advantage	3
C.	Possesses two or more characteristics that increase competitive advantage	6
U.	Unknown	

Score: 6

Documentation:
Evidence of competitive ability:
Perennial; distinct cytotypes that exploit both sexual and vegetative reproduction.

It has very wide range of hardiness (zones 3-10) (IPANE, 2012).

Exibits high ecological amplitude with regard to water level- reproduces in stable water levels (Hroudova, 1989) or fluctuiating water levels (Hroudova, et al. 1996).

While some populations reportedly often do not flower, as in Connecticut (IPANE, 2012) or produce infertile seed as in Minnesota (Killeffer, 2004); one study (Brown & Eckert, 2005) found that some introduced North American populations invested much more biomass into sexual inflorescence and clonal asexual bulbil reproduction than compared to European populations. This extreme variation in sexual fertility may be due to two distinct cytotypes (diploid & triploid) of Butomus colonizing North America (Lui, et al., 2005). One study suggests that the triploid race has greater ecological amplitude (Lui, et al., 2005). Another study suggests that polyploidy itself may facilitate biological invasions (te Beest, et al., 2012).

Sources of information:
Brown & Eckert, 2005; Haynes, 2000; Hroudova, 1989; Hroudova, et al., 1996; IPANE, 2012; Killeffer, 2004; Lui, et al., 2005; te Beest, et al., 2012.

2.5. Growth vigor

A.	Does not form thickets or have a climbing or smothering growth habit	0
B.	Has climbing or smothering growth habit, forms a dense layer above shorter vegetation, forms dense thickets, or forms a dense floating mat in aquatic systems where it smothers other vegetation or organisms	2
U.	Unknown	

Score: 0

Documentation:
Describe growth form:
Although no studies were located which specified a smothering or climbing habit; one study in the St Lawrence River wetlands of southern Québec stated that Butomus was "much more invasive" than purple loosesrife (Lythrum salicaria) (Lavoie, et al., 2003). However another study conducted found that Butomus while present, was rarely dominant along the shores of the lower Great Lakes (Trebitz & Taylor, 2007).
Sources of information:
Lavoie, et al., 2003; Trebitz & Taylor, 2007.

2.6. Germination/Regeneration

A.	Requires open soil or water and disturbance for seed germination, or regeneration from vegetative propagules.	0
B.	Can germinate/regenerate in vegetated areas but in a narrow range or in special conditions	2
C.	Can germinate/regenerate in existing vegetation in a wide range of conditions	3
U.	Unknown (No studies have been completed)	

Score: 2

Documentation:
Describe germination requirements:
One greenhouse study (Eckert, et al., 2000) found germination rates of 31% after a 6 week cold stratification period. This same study relates the Muenscher (1936) experiment which found that the proportion of seeds germinated increased strongly with the length of the cold stratification period; this same phenonenom was reported by Crocker (1938) and Hroudova & Zakravsky (2003). Seeds reportedly can also germinate in flooded conditions (Hroudova & Zakravsky, 2003). Another study stated that seeds germinate readily under sterile conditions (Lieu, 1979). Regeneration also occurs via bulbils.

Sources of information:
Crocker, 1938; Eckert, et al., 2000; Hroudova & Zakravsky, 2003; Lieu, 1979; Muenscher, 1936.

2.7. Other species in the genus invasive in New York or elsewhere

A.	No	0
B.	Yes	3
U.	Unknown	

Score 0

Documentation:
Species:
Most authors recognize this as a monotypic family, no cogeners possible.

Total Possible 25
Section Two Total 18

3. ECOLOGICAL AMPLITUDE AND DISTRIBUTION

3.1. Density of stands in natural areas in the northeastern USA and eastern Canada (use same definition as Gleason & Cronquist which is: "The part of the United States covered extends from the Atlantic Ocean west to the western boundaries of Minnesota, Iowa, northern Missouri, and southern Illinois, south to the southern boundaries of Virginia, Kentucky, and Illinois, and south to the Missouri River in Missouri. In Canada the area covered includes Nova Scotia, Prince Edward Island, New Brunswick, and parts of Quebec and Ontario lying south of the 47th parallel of latitude")

A.	No large stands (no areas greater than 1/4 acre or 1000 square meters)	0
B.	Large dense stands present in areas with numerous invasive species already present or disturbed landscapes	2
C.	Large dense stands present in areas with few other invasive species present (i.e. ability to invade relatively pristine natural areas)	4
U.	Unknown	

Score 2

Documentation:
Identify reason for selection, or evidence of weedy history:
Gaiser (1949) refers to a specimen from Michigan with the label stating "it covered acres of land."
Sources of information:
Gaiser, 1949

3.2. Number of habitats the species may invade

A.	Not known to invade any natural habitats given at A2.3	0
B.	Known to occur in one natural habitat given at A2.3	1
C.	Known to occur in two natural habitats given at A2.3	2
D.	Known to occur in three natural habitat given at A2.3	4
E.	Known to occur in four or more natural habitats given at A2.3	6
U.	Unknown	

Score 4

Documentation:
Identify type of habitats where it occurs:
see A 2.3
Sources of information:
Haynes, 2000; IPANE, 2012; Marsden & Hauser, 2009; Roberts, 1972; Weldy & Werier, 2012; Witmer, 1964.

3.3. Role of disturbance in establishment

A.	Requires anthropogenic disturbances to establish.	0
B.	May occasionally establish in undisturbed areas but can readily establish in areas with natural or anthropogenic disturbances.	2
C.	Can establish independent of any known natural or anthropogenic disturbances.	4
U.	Unknown	

Score 2

Documentation:
Identify type of disturbance:
This plant is a "pioneer" and can easily invade areas that are not occupied by other plants (Minnesota Sea Grant, 2009).

One British reference states that "though not normally to be regarded as a pioneer on mud, large numbers of seedlings have been observed at an early phase of the mud succession, in one or two localities" (Salisbury, 1970).
"While disturbances can play an important role in increasing the rate of invasion, populations of flowering rush are also very capable of establishing and becoming dominant at a site independent of disturbances" (Colorado NWAC 2008). However support for this statement could not be found in the three references cited.
Sources of information:
Minnesota Sea Grant, 2009; Salisbury,1970; CO Noxious Weed Advisory Committee 2008.

3.4. Climate in native range

A.	Native range does not include climates similar to New York	0
B.	Native range possibly includes climates similar to at least part of New York.	1
C.	Native range includes climates similar to those in New York	3
U.	Unknown	

Score 3

Documentation:
Describe what part of the native range is similar in climate to New York:
Eurasia
Sources of information:
Anderson, et al., 1974; Haynes, 2000

3.5. Current introduced distribution in the northeastern USA and eastern Canada (see question 3.1 for definition of geographic scope)

A.	Not known from the northeastern US and adjacent Canada	0
B.	Present as a non-native in one northeastern USA state and/or eastern Canadian province.	1
C.	Present as a non-native in 2 or 3 northeastern USA states and/or eastern Canadian provinces.	2
D.	Present as a non-native in 4–8 northeastern USA states and/or eastern Canadian provinces, and/or categorized as a problem weed (e.g., "Noxious" or "Invasive") in 1 northeastern state or eastern Canadian province.	3
E.	Present as a non-native in >8 northeastern USA states and/or eastern Canadian provinces. and/or categorized as a problem weed (e.g., "Noxious" or "Invasive") in 2 northeastern states or eastern Canadian provinces.	4
U.	Unknown	

Score 4

Documentation:
Identify states and provinces invaded:
CT, IL, IN, ME, MI, MN, NY, OH, PA, VT, WI; N. B., N.S., Ont., P.E.I., Que.
Sources of information: See known introduced range in plants.usda.gov, and update with information from states and Canadian provinces.
Gaiser, 1949; George Safford Torrey Herbarium (CONN), 2012; Haynes, 2000; Mills, et al.,

1996; Roberts, 1972; USDA, 2012; Weldy & Werier, 2012.; Witmer, 1964

3.6. Current introduced distribution of the species in natural areas in the eight New York State PRISMs (Partnerships for Regional Invasive Species Management)

A.	Present in none of the PRISMs	0
B.	Present in 1 PRISM	1
C.	Present in 2 PRISMs	2
D.	Present in 3 PRISMs	3
E.	Present in more than 3 PRISMs or on the Federal noxious weed lists	4
U.	Unknown	

Score: 4

Documentation:
Describe distribution:
See Section A1.2
Sources of information:
Mills, et al., 1996; Weldy & Werier, 2012.

Total Possible: 25
Section Three Total: 19

4. DIFFICULTY OF CONTROL

4.1. Seed banks

A.	Seeds (or vegetative propagules) remain viable in soil for less than 1 year, or does not make viable seeds or persistent propagules.	0
B.	Seeds (or vegetative propagules) remain viable in soil for at least 1 to 10 years	2
C.	Seeds (or vegetative propagules) remain viable in soil for more than 10 years	3
U.	Unknown	

Score: 2

Documentation:
Identify longevity of seed bank:
One study conducted in China found that Butomus umbellatus does seed bank to certain degree, but longevity numbers were lacking. Crocker (1938) obtained a 9% germination rate of 7.5 year old dried Butomus seeds.
Sources of information:
Crocker, 1938; Li, et al., 2008

4.2. Vegetative regeneration

A.	No regrowth following removal of aboveground growth	0
B.	Regrowth from ground-level meristems	1
C.	Regrowth from extensive underground system	2
D.	Any plant part is a viable propagule	3
U.	Unknown	

Score: 2

Documentation:
Describe vegetative response:
One study found this species has a "great ability" to reproduce vegetatevely by rhizome fragments (Hroudova, 1989).
Corm-like bulbils are also formed from axillary buds which are easily detached from and germinate the following spring, forming small individual plants (Lieu, 1979).

Sources of information:
Hroudova, 1989; Lieu, 1979).

4.3. Level of effort required

A.	Management is not required: e.g., species does not persist without repeated anthropogenic disturbance.	0
B.	Management is relatively easy and inexpensive: e.g. 10 or fewer person-hours of manual effort (pulling, cutting and/or digging) can eradicate a 1 acre infestation in 1 year (infestation averages 50% cover or 1 plant/100 ft^2).	2
C.	Management requires a major short-term investment: e.g. 100 or fewer person-hours/year of manual effort, or up to 10 person-hours/year using mechanical equipment (chain saws, mowers, etc.) for 2-5 years to suppress a 1 acre infestation. Eradication is difficult, but possible (infestation as above).	3
D.	Management requires a major investment: e.g. more than 100 person-hours/year of manual effort, or more than 10 person hours/year using mechanical equipment, or the use of herbicide, grazing animals, fire, etc. for more than 5 years to suppress a 1 acre infestation. Eradication may be impossible (infestation as above).	4
U.	Unknown	

Score 4

Documentation:
Identify types of control methods and time-term required:
Multiple cuttings in one year below water level reduces abundance but all parts of the plant must be removed (Killeffer, 2004).

Cutting flowering rush below the water surface is an effective method of control. Cutting will not kill the plant, but it will decrease the abundance. Multiple cuts may be required throughout the summer as flowering rush grows back from the root. All cut plant parts must be removed from the water.
Hand digging can be used to remove isolated plants that are located downstream of larger infestations. Extreme care must be taken to remove all root fragments. Any disturbance to the root system will cause small reproductive structures on the roots to break off and spread to other areas of the waterbody. Therefore, methods such as raking or pulling which disturb the root system, but do not remove it, are not recommended control strategies.
It is very difficult to kill flowering rush with herbicides. Herbicides easily wash away from the narrow leaves of this plant. Herbicides are more effective on dry banks or in very shallow water. There is no herbicide that is selective for flowering rush and care must be taken to avoid damage to valuble wetland plants such as cattails (Minnesota Sea Grant, 2009).

In Montana preliminary results suggest spraying during the spring draw-down period on lakes/ponds after five to seven inches (12.7 to 17.8 centimeters) of leaves had emerged from the exposed lake bed was most effective. Imazapyr (Habitat®) and imazomox (Clearcast®) suppressed flowering rush for one season but did not kill rhizomes (Jacobs, et al., 2011).

Intentional draw-downs might be a strategy, especially of smaller ponds- one study suggests severe or long-lasting decreases in water level could result in the reduction of B. umbellatus populations (Hudon 2004).

Sources of information:
Hudon 2004; Jacobs, et al., 2011; Killeffer, 2004; Minnesota Sea Grant, 2009

Total Possible	10
Section Four Total	8
Total for 4 sections Possible	80
Total for 4 sections	51

C. STATUS OF CULTIVARS AND HYBRIDS:

At the present time (May 2008) there is no protocol or criteria for assessing the invasiveness of cultivars independent of the species to which they belong. Such a protocol is needed, and individuals with the appropriate expertise should address this issue in the future. Such a protocol will likely require data on cultivar fertility and identification in both experimental and natural settings.

Hybrids (crosses between different parent species) should be assessed individually and separately from the parent species wherever taxonomically possible, since their invasiveness may differ from that of the parent species. An exception should be made if the taxonomy of the species and hybrids are uncertain, and species and hybrids can not be clearly distinguished in the field. In such cases it is not feasible to distinguish species and hybrids, and they can only be assessed as a single unit.

Some cultivars of the species known to be available:

References for species assessment:

Anderson, L. C. et al. 1974. Phytogeography and possible origins of Butomus in North America, Bull. Torrey Bot. Soc. 101:(5):292-296.

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