Cal-IPC Plant Assessment Form

For use with "Criteria for Categorizing Invasive Non-Native Plants that Threaten Wildlands"
by the California Invasive Plant Council and the Southwest Vegetation Management Association

Version February 2003, modified March 2009
California Invasive Plant Council (formerly CA Exotic Pest Plant Council)
Berkeley, CA www.cal-ipc.org, phone (510) 843-3902

Table 1. Species and Evaluator Information

Species name (Latin binomial)**:**	*Nanozostera japonica* (Asch. & Graebn.) P. Toml. & U. Posl.
Synonyms:	*Zostera japonica* Asch. & Graebn.
Common names:	Dwarf eelgrass, Japanese eelgrass
Evaluation date (mm/dd/yy)**:**	5/18/11
Evaluator #1 Name/Title:	Elizabeth Brusati, Program Manager
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Section below for list committee use—please leave blank

List committee members:	enter text here
Committee review date:	enter text here
List date:	enter text here
Re-evaluation date(s):	enter text here

General comments on this assessment:

This PAF is based on information provided by Kirsten Ramey with the California Department of Fish and Game, kramey@dfg.ca.gov, 707-445-5365.

Zostera japonica seems to have been recently reclassified as *Nanozostera japonica*. Most references cite it as *Z. japonica*.

This species has many documented impacts in Oregon and Washington but due to its limited extent so far in California, there is not much data specific to California. Therefore, some questions are scored low because *N. japonica* has not spread enough to create significant impacts here. However, impacts are likely to increase if populations expand and spread to new estuaries.

Table 2. Criteria, Section, and Overall Scores

Species: *Nanzostera japonica* **Region:** statewide

1.1	Impact on abiotic ecosystem processes	**B**	**Rev'd Sci Pub (4)**
1.2	Impact on plant community	**C**	**Rev'd Sci Pub (4)**
1.3	Impact on higher trophic levels	**B**	**Rev'd Sci Pub (4)**
1.4	Impact on genetic integrity	**D**	**Rev'd Sci Pub (4)**

Impact

Enter four characters from Q1.1-1.4 below:

BCBD

Using matrix, determine score and enter below:

B

2.1	Role of anthropogenic and natural disturbance	**A (3)**	**Rev'd Sci Pub (4)**
2.2	Local rate of spread with no management	**B (2)**	**Observational (2)**
2.3	Recent trend in total area infested within state	**B (2)**	**Observational (2)**
2.4	Innate reproductive potential Wksht A	**A (3)**	**Rev'd Sci Pub (4)**
2.5	Potential for human-caused dispersal	**C (1)**	**Observational (2)**
2.6	Potential for natural long-distance dispersal	**C (1)**	**Observational (2)**
2.7	Other regions invaded	**C (1)**	**Rev'd Sci Pub (4)**

Invasiveness

Enter the sum total of all points for Q2.1-2.7 below:

13

Use matrix to determine score and enter below:

B

Plant Score

Using matrix, determine Overall Score and Alert Status from the three section scores and enter below:

Moderate

Alert

3.1	Ecological amplitude/Range	**C**	**Rev'd Sci Pub**
3.2	Distribution/Peak frequency Wksht C	**D**	**Observational**

Distribution

Using matrix, determine score and enter below:

C

Documentation

Average of all questions

3.2 out of 4.0

Table 3. Documentation (List all references at end of PAF. Short citations may be used in Table 3.)

Impacts

Question 1.1 Impact on abiotic ecosystem processes B Rev'd Sci Pub back

Identify ecosystem processes impacted; *N. japonica* colonizes intertidal mud and sand flats that lack permanent macrophyte cover (Harrison and Bigley 1982, Posey 1988, Thom 1990, Larned 2003). The physical structure of the mid to upper intertidal zones is altered where *N. japonica* occurs, often forming a dense, sod-like root matrix that may completely cover the substrate surface (Posey 1988). The narrow blades trap fine sediments. Posey (1988) documented that particle size was significantly smaller in *Z. japonica* patches after six years.

Larned (2003) documented changes in nutrient fluxes in Oregon estuaries after invasion by Z. japonica. The data demonstrate that Z. japonica invasions alter water column benthos nutrient fluxes. These alterations may in turn affect pelagic primary production.

These impacts are based on studies from Oregon and Washington as not much information is available specifically from California but it seems likely that similar impacts may be occurring in Humboldt Bay (reviewer comment).

Sources of information: Harrison and Bigley 1982, Larned 2003, Posey 1988, Thom 1990

Question 1.2 Impact on plant community composition, structure, and interactions C Rev'd Sci Pub back

Identify type of impact or alteration: Bando (2006) reported that in Washington, *Z. japonica* is also invading vegetated flats historically dominated by *Zostera marina*. *N. japonica* generally occurs higher in the intertidal than the native eelgrass *Z. marina*, but the two are sometimes intermixed with each other and/or various algal species (Harrison 1982, Thom 1990, Baldwin and Lovvorn 1994a, Bulthuis 1995). Expansion of *N. japonica* is characterized by rapid growth and spread during spring and summer (Harrison 1982). The species has become well established in estuaries throughout Washington and Oregon, covering thousands of acres (Baldwin and Lovvorn 1994a, Dudoit 2006).

Scored lower because populations and impacts in California are currently limited.

Sources of information: Bando 2006, Baldwin and Lovvorn 1994a, Bulthuis 1995, Dudoit 2006, Harrison 1982, Thom 1990

Question 1.3 Impact on higher trophic levels B Rev'd Sci Pub back

Identify type of impact or alteration:

Substrate particle size affects which invertebrates can inhabit the sediment and this change in invertebrate community structure can impact shorebird populations that feed on invertebrates (Quammen 1984, Baldwin and Lovvorn 1994b, Danufsky and Colwell 2003). A decrease in the burrowing ghost shrimp (*Neotrypaea californiensis*) and other large epifauna was found in areas of *N. japonica* in Washington (Harrison 1987, Posey 1988). *N. californiensis* is a favored prey for the long-billed curlew and found in the diets of the marbled godwit and willet (Dr. Nils Wornock, pers. comm., Point Reyes Bird Observatory).

As *Nanozostera japonica* covers mudflats that otherwise lack permanent macrophyte cover, it could reduce the foraging areas needed by shorebirds. The estuaries *N. japonica* is invading are important migration and wintering grounds for many birds.

Sources of information: Baldwin and Lovvorn 1994b, CDFG 2009, Danufsky and Colwell 2003, Harrison 1987, Posey 1988, Quammen 1984

Question 1.4 Impact on genetic integrity D Rev'd Sci Pub. back

Identify impacts: *Nanozostera japonica* is invading estuaries that contain native *Zostera marina*, although there is no information on hybridization.

Sources of information: Kirsten Ramey, California Department of Fish and Game, Dean et al. (2008)

Invaseness

Question 2.1 Role of anthropogenic and natural disturbance in establishment — A Rev'd Sci Pub back

Describe role of disturbance: Often invades areas with little or no natural or human disturbance. A study conducted by Bando (2006) did show that *N. japonica* displays a positive response to disturbance, which is particularly relevant to its invasion success, as tidal flats are dynamic systems that experience high levels of natural and anthropogenic disturbance, including bioturbation, coastal development, boating, shellfish culture, and in some regions (Washington), invasive smooth cordgrass (Spartina alterniflora) control.

Sources of information: Bando 2006

Question 2.2 Local rate of spread with no management — B Observational back

Describe rate of spread: *N. japonica* was discovered at the southwest end of Indian Island in Humboldt Bay, Humboldt County, California, in June 2002. In November 2006, *N. japonica* was found near the Arcata Wastewater Treatment Plant in North Humboldt Bay. In March 2007, a fairly substantial population of *Z. japonica* at the Arcata Marsh, near the boat ramp at the foot of I Street in Arcata, CA, was found. In August 2007, a third new occurrence of *N. japonica* growing on intertidal mudflats in Manila, CA, was discovered. On April 28, 2008, a new population of *Z. japonica* was discovered by a DFG crew in McNulty Slough in the Eel River estuary. McNulty Slough winds along the eastern boundary of the Department of Fish and Game Eel River Wildlife Area north of the mouth of the Eel River, Humboldt County, California.

Sources of information: Kristen Ramey, California Department of Fish and Game

Question 2.3 Recent trend in total area infested within state — B Observational back

Describe trend: See information in question 2.2. Populations of the plant are expanding.

A study by Shafer et al (2008) examined growth and productivity of Z. japonica at several points in its range on the Pacific Coast of North America and concluded that southern populations may be better adapted to warmer conditions than northern populations, suggesting that Z. japonica could expand further south in California.

Sources of information: Kirsten Ramey, California Department of Fish and Game, Shafer et al. 2008

Question 2.4 Innate reproductive potential — A Rev'd Sci Pub back

Describe key reproductive characteristics: It is an annual, overwintering as buried seeds, or a short-lived perennial (Harrison 1982). *Z. japonica* reproduces vegetatively through rhizomatous cloning and sexually through seed production (Phillips 1984).

Sources of information: Harrison 1982, Phillips 1984

Question 2.5 Potential for human-caused dispersal — A Rev'd Sci Pub back

Identify dispersal mechanisms: *Z. japonica* likely arrived on the Pacific Coast of North America coincident with the introduction of oysters from Japan as packing material or as seed on oyster shell (Harrison and Bigley 1982). The introduction of Z japonica to Humboldt Bay was NOT likely associated with oyster culture, as oyster larvae imported here come from hatcheries. The method of introduction into Humboldt Bay is unknown. The detection of *Z. japonica* in Humboldt Bay, California, in June 2002 represents the first time this introduced species has been encountered in California.

The method of spread around Humboldt Bay and to McNulty Slough is unknown, however, two locations of invasion have been at small public boat ramps which may suggest that plant material or seeds can be dispersed in mud stuck to boat hulls, boots and gear.

Sources of information: Kirsten Ramey, California Department of Fish and Game, CDFG 2009

Question 2.6 Potential for natural long-distance dispersal C Observational back

Identify dispersal mechanisms: The widespread and ongoing dispersal, both within and between estuaries, may be aided by waterfowl species such as Brant geese. The Brant diet includes substantial amounts of *Z. japonica*, suggesting it is likely that the small goose has become a vector for dispersal of the non-native eelgrass. The possibility that Brant are capable of transporting viable *Z. japonica* seeds in their guts is being further explored by researches at Oregon State University.

Sources of information: Kirsten Ramey, California Department of Fish and Game

Question 2.7 Other regions invaded C Rev'd Sci Pub back

Identify other regions: *Z. japonica* was first detected in Washington in 1957 (Hitchcock et al. 1969), in British Columbia in 1969 (Harrison and Bigley 1982), and in Oregon in 1975 (Posey 1988).

As an intertidal and subtidal plant, it is restricted to only one ecological type.

Sources of information: Harrison and Bigley 1982, Hitchcock et al. 1969, Posey 1988

Distribution

Question 3.1 Ecological amplitude/Range C Rev'd Sci Pub back

Describe ecological amplitude, identifying date of source information and approximate date of introduction to the state, if known: *Z. japonica* was discovered at the southwest end of Indian Island in Humboldt Bay, Humboldt County, California, in June 2002. In November 2006, *Z. japonica* was found near the Arcata Wastewater Treatment Plant in North Humboldt Bay. In March 2007, a fairly substantial population of *Z. japonica* at the Arcata Marsh, near the boat ramp at the foot of I Street in Arcata, CA, was found. In August 2007, a third new occurrence of *Z. japonica* growing on intertidal mudflats in Manila, CA, was discovered. On April 28, 2008, a new population of *Z. japonica* was discovered by a DFG crew in McNulty Slough in the Eel River estuary. McNulty Slough winds along the eastern boundary of the Department of Fish and Game Eel River Wildlife Area north of the mouth of the Eel River, Humboldt County, California.

It inhabits mud flats between low and semi-high tide marks.

Sources of information: Kirsten Ramey, California Department of Fish and Game,

Question 3.2 Distribution/Peak frequency D Observational back

Describe distribution: Currently limited to Humboldt County. However, Shafer et al (2008) examined growth and productivity of Z. japonica at several points in its range on the Pacific Coast of North America and concluded that southern populations may be better adapted to warmer conditions than northern populations, suggesting that Z. japonica could expand further south in California.

Sources of information: Kirsten Ramey, California Dept. of Fish and Game; Shafer et al. 2008

References

List full citations for all references used in the PAF (short citations such as DiTomaso and Healy 2007 may be used in table above). **Websites** should include the name of the organization and the date accessed. **Personal communications** should include the affiliation of the person providing the observation. Enter each reference on a separate line; the table will expand as needed.

Examples:

Mitich, L. W. 1995. Intriguing world of weeds: Tansy ragwort. Weed Technology. 9: 402-404.

HEAR. Date unknown. Emex spinosa. Hawaiian Ecosystems at Risk. www.hear.org/pier/species/emex_spinosa.htm. Accessed March 17, 2009

DiTomaso, J. M. Personal communication from Dr. Joe DiTomaso, Dept. of Plant Science, UC Davis. Email received 3/17/09.

Baldwin, J. R. and J. R. Lovvorn. 1994a. Expansion of seagrass habitat by the exotic Zostera japonica, and its use by dabbling ducks and brant in Boundary Bay, British Columbia. Marine Ecology Progress Series [Mar. Ecol. Prog. Ser.] 103:119-127.

Baldwin, J. R. and J. R. Lovvorn. 1994b. Habitats and tidal accessibility of the marine foods of dabbling ducks and brant in Boundary Bay, British Columbia. Marine Biology [Mar. Biol.] 120:627-638.

Bando, K. 2006. The roles of competition and disturbance in a marine invasion. Biological Invasions 8:755-763.

Bulthuis, D. A. 1995. Distribution of seagrasses in a North Puget Sound estuary: Padilla Bay, Washington, USA. Aquatic Botany [Aquat. Bot.] 50:99-105.

CDFG. 2009. Stop the spread of dwarf eelgrass. California Dept. of Fish and Game. Brochure available at www.dfg.ca.gov/invasives

Danufsky, T. and M. A. Colwell. 2003. Winter shorebird communities and tidal flat characteristics at Humboldt Bay, California. The Condor 105:117-129.

Dean, E.., F. Hrusa, G. Leppig, A. Sanders, and B. Ertter. 2008. Catalogue of nonnative vascular plants occurring spontaneously in California beyond those addressed in the Jepson Manual – Part II. Madroño. 55(2): 93-112

Dudoit, C. 2006. The Distribution and Abundance of a Non-native Eelgrass, Zostera japonica, in Oregon Estuaries. Oregon State University, Corvallis, Oregon.

Harrison, P. G. 1982. Comparative growth of Zostera japonica and Zostera marina under simulated intertidal and subtidal conditions. Aquatic Botany 14:373-380.

Harrison, P. G. 1987. Natural expansion and experimental manipulation of seagrass (Zostera spp.) abundance and the response of infaunal invertebrates. Estuarine, Coastal and Shelf Science [Estuar. Coast. Shelf Sci.] 24:799-812.

Harrison, P. G. and R. E. Bigley. 1982. The recent introduction of the seagrass Zostera japonica Aschers. and Graebn. to the Pacific Coast of North America. Canadian Journal of Fisheries and Aquatic Sciences 39:1642-1648.

Hitchcock, C. L., A. Cronquist, M. Ownbey, and J. W. Thompson. 1969. Vascular plants of the Pacific Northwest : part 1. vascular cryptogams, gymnosperms, and monocetyledons. University of Washington, Seattle.

Larned, S. T. 2003. Effects of the invasive, nonindigenous seagrass Zostera japonica on nutrient fluxes between the water column and benthos in a NE Pacific estuary. Marine Ecology Progress Series [Mar. Ecol. Prog. Ser.] 254:69-80.

Phillips, R. C. 1984. Ecology of eelgrass meadows in the Pacific northwest: A community profile. US Fish and Wildlife Service.

Posey, M. H. 1988. Community changes associated with the spread of an introduced seagrass, Zostera japonica. Ecology 69:974-983.

Quammen, M. L. 1984. Predation by shorebirds, fish, and crabs on invertebrates in intertidal mudflats: An experimental test. Ecology 65:529-537.

Shafer, D.J., S. Wyllie-Echeverria, and T. D. Sherman. 2008. The potential role of climate in the distribution and zonation of the introduced seagrass Zostera japonica in North America. Aquatic Botany 89: 297–302

Thom, R. M. 1990. Spatial and temporal patterns in plant standing stock and primary production in a temperate seagrass system. Botanica Marina 33:497-510.

For further information, please contact Kirsten Ramey, California Department of Fish and Game, kramey@dfg.ca.gov, 707-445-5365, or Annie Eicher, Staff Research Associate, aleicher@ucdavis.edu, UC Sea Grant Extension Program, 707-443-8369

Worksheet A

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Reaches reproductive maturity in 2 years or less	**Yes (1)**
Dense infestations produce >1,000 viable seed per square meter	**Unknown (0)**
Populations of this species produce seeds every year.	**Yes (1)**
Seed production sustained over 3 or more months within a population annually	**Unknown (0)**
Seeds remain viable in soil for three or more years	**Unknown (0)**
Viable seed produced with *both* self-pollination and cross-pollination	**Unknown (0)**
Has quickly spreading vegetative structures (rhizomes, roots, etc.) that may root at nodes	**Yes (1)**
Fragments easily and fragments can become established elsewhere	**Yes (2)**
Resprouts readily when cut, grazed, or burned	**Yes (1)**
	Total = 6 pts 4 unknowns
	A

Note any related traits: enter text here

Worksheet C - California Ecological Types

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(*sensu* Holland 1986)

Major Ecological Types	Minor Ecological Types	Code*
Marine Systems	marine systems	**score**
Freshwater and Estuarine Aquatic Systems	lakes, ponds, reservoirs	**score**
	rivers, streams, canals	**score**
	estuaries	**D(<5%)**
Dunes	coastal	**score**
	desert	**score**
	interior	**score**
Scrub and Chaparral	coastal bluff scrub	**score**
	coastal scrub	**score**
	Sonoran desert scrub	**score**
	Mojavean desert scrub (incl. Joshua tree woodland)	**score**
	Great Basin scrub	**score**
	chenopod scrub	**score**
	montane dwarf scrub	**score**
	Upper Sonoran subshrub scrub	**score**
	chaparral	**score**
Grasslands, Vernal Pools, Meadows, and other Herb Communities	coastal prairie	**score**
	valley and foothill grassland	**score**
	Great Basin grassland	**score**
	vernal pool	**score**
	meadow and seep	**score**
	alkali playa	**score**
	pebble plain	**score**
Bog and Marsh	bog and fen	**score**
	marsh and swamp	**score**
Riparian and Bottomland	riparian forest	**score**
	riparian woodland	**score**
	riparian scrub (incl.desert washes)	**score**
Woodland	cismontane woodland	**score**
	piñon and juniper woodland	**score**
	Sonoran thorn woodland	**score**
Forest	broadleaved upland forest	**score**
	North Coast coniferous forest	**score**
	closed cone coniferous forest	**score**
	lower montane coniferous forest	**score**
	upper montane coniferous forest	**score**
	subalpine coniferous forest	**score**
Alpine Habitats	alpine boulder and rock field	**score**
	alpine dwarf scrub	**score**

* A. means >50% of type occurrences are invaded; B means >20% to 50%; C. means >5% to 20%; D. means present but ≤5%; U. means unknown (unable to estimate percentage of occurrences invaded).