Landscape performance of 3 *Polygonella* wildflower species native to Florida

Mack Thetford, Alison E O'Donoughue, Sandra B Wilson, and Hector E Pérez

ABSTRACT

Largeleaf jointweed (*Polygonella macrophylla* Small), October flower (*Polygonella polygama* (Vent. Engelm. & A. Gray), and sandhill wireweed (*Polygonella robusta* (Small) G.L. Neson & V.M. Bates) are wildflowers of the Polygonaceae that exhibit good form and showy flower displays within their natural growing environments. Softwood cuttings of each *Polygonella* species were collected from natural areas in Florida and produced in standard #1 (3.7 l) containers to evaluate the establishment, growth, and flowering of the 3 species within 3 distinct growing regions of Florida. Plants of each species produced from cuttings were evaluated in common-garden landscape trials located in north (Milton), central (Gainesville), and south (Fort Pierce) Florida. All 3 *Polygonella* species outplanted successfully at each location, and survival exceeded 80% within 28 wk after planting. Flower impact, visual quality, and growth of each species varied by location and time, with peak performance occurring in November.

Thetford M, O'Donoughue AE, Wilson SB, Pérez HE. 2018. Landscape performance of 3 *Polygonella* wildflower species native to Florida. Native Plants Journal 19(3):239–247.

KEY WORDS
softwood cuttings, wireweed, October flower, jointweed, *Polygonella macrophylla, Polygonella polygama, Polygonella robusta*, Polygonaceae

NOMENCLATURE
Wunderlin and Hansen (2003)

Largeleaf jointweed (*Polygonella macrophylla* Small), October flower (*Polygonella polygama* (Vent.) Engelm. & A. Gray), and sandhill wireweed (*Polygonella robusta* (Small) G.L. Nesom & V.M. Bates) are Florida native wildflowers (Wunderlin and Hansen 2003) of the Polygonaceae with excellent ornamental potential but of limited commercial availability (Figure 1). Of the 3 species, *P. macrophylla* is endemic to north Florida occurring only in the panhandle region; *P. polygama* is present in all 3 regions of the state, and *P. robusta* occurs in central and south Florida (Figure 2).

Polygonella macrophylla is perennial and, although common to scrub and sandhills of northwestern Florida and the southern Alabama Gulf Coast, is classified as threatened, thus limiting its collection (Coile and Garland 2003). Of the *Polygonella* found in Florida, *P. macrophylla* has the broadest leaves and white, pink, or red flowers borne on racemes up to 6 cm (2.4 in) long (Horton 1963). Lewis and Crawford (1995) suggested that *P. macrophylla* is most closely related to the more widespread *P. polygama*, based on morphological data. Within the Fort Pickens Aquatic Preserve (northwest Florida), it is found often in stable coastal dunes and in coastal scrub (FDEP 2009).

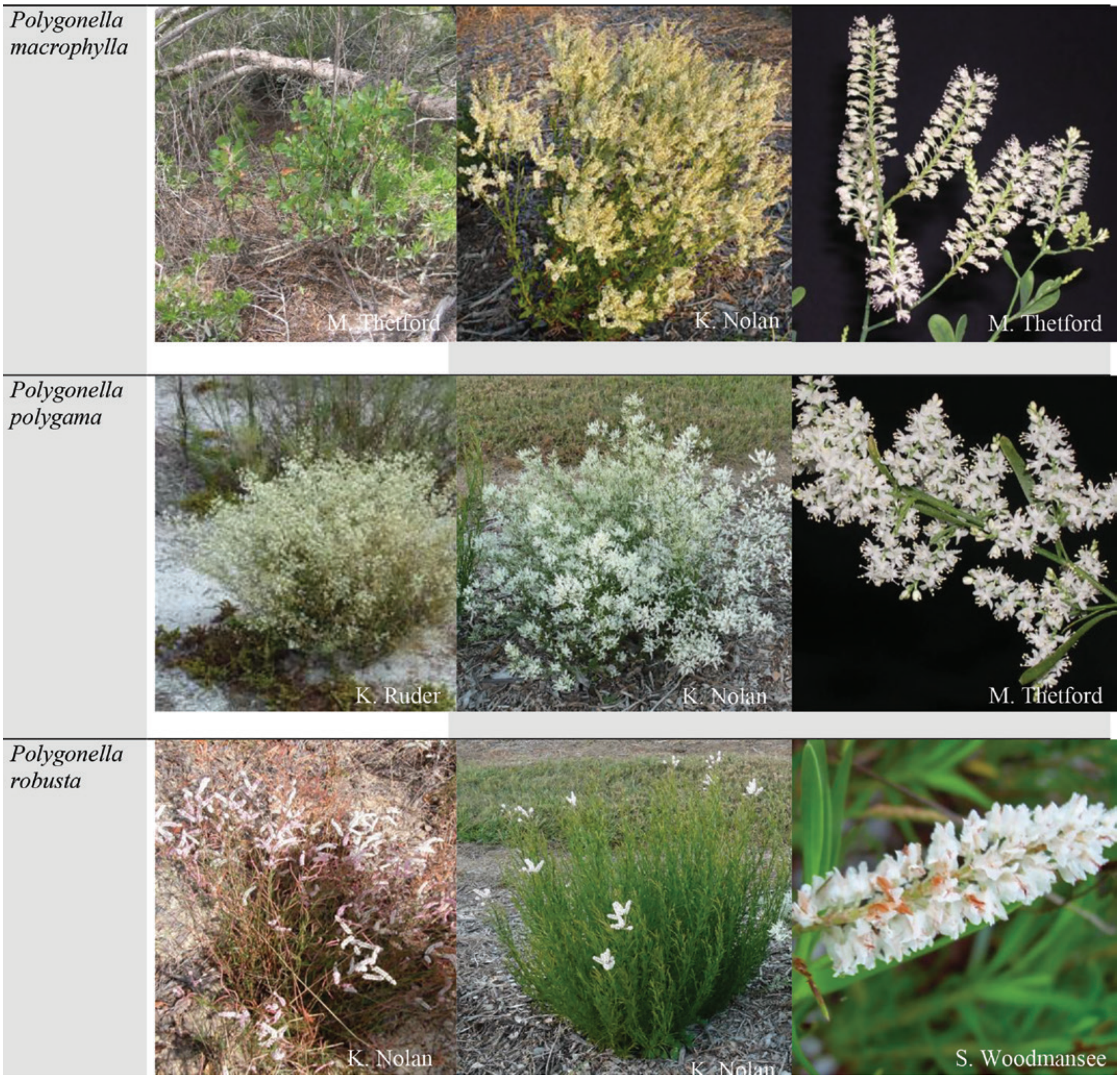

Figure 1. Images of 3 *Polygonella* species in Florida native plant communities, with plants and inflorescence of plants grown in common-garden trials.

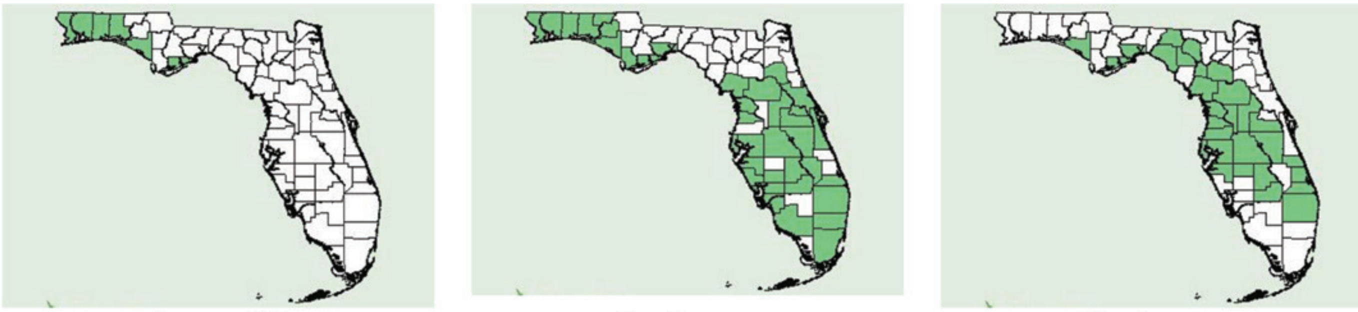

Figure 2. Distribution of largeleaf jointweed (*Polygonella macrophylla*), October flower (*P. polygama*) and sandhill wireweed (*P. robusta*) in Florida based on vouchered specimens reported in the Atlas of Florida Vascular Plants (http://www.florida.plantatlas.usf.edu).

Polygonella polygama var. *polygama* is an herbaceous perennial wildflower that is found in sandhills, flatwoods, and scrub, in full to partial sun within coastal plain regions of the southeastern US (Wunderlin and Hansen 2003, 2009). Commonly called October flower, this *Polygonella* is frequently found in open spaces (Taylor 1998; Osorio 2001; Wunderlin and Hansen 2003). October flower has spatulate to linear leaves, and the stem has some jointing visible; flowers are cream to yellow and usually appear in late fall on terminal racemes. During these experiments we observed that flowers of *P. polygama* had a light fragrance similar to jasmine. Although not used in this study, note that a second (less common) variety exists by the name *Polygonella polygama* var. *brachystachya* (Meisn.) Wunderlin. This variety is found mostly in flatwoods and can be distinguished from *P. polygama* var. *polygama* by its wider and longer leaves (Wunderlin and Hansen 2003).

Polygonella robusta is most commonly found in open sand, full sun environments along the coasts of Florida (Wunderlin and Hansen 2009). This mounding herbaceous perennial has linear leaves and the stems have fibrous hairs at each node and appear jointed due to a sheathing petiole. Like *P. polygama,* it is also floriferous but with terminal pink to cream flowers that appear sporadically throughout the year. The species naturally occurs only within the state of Florida and is well distributed throughout all parts of Florida (Taylor 1998; Osorio 2001; Wunderlin and Hansen 2003). Neither *P. polygama* nor *P. robusta* is widespread in cultivation. Seed collection from natural populations can be restricted by varying seasonal conditions, management practices, or narrow harvest windows (Ingram and Yeager 1990). Although a few native nurseries produce both species from seed, germination often does not exceed 25% (Bissett 2010). Heather and others (2010) attributed delayed, erratic, or reduced seed germination of *P. polygama* and *P. robusta* to physiological dormancy, collection site, and storage conditions. We have demonstrated propagation of *Polygonella* by cuttings (80% or greater) using Fafard 3B (Sun Gro Horticulture, Agawam, Massachusetts) or a mixture (50:50 by volume) of horticultural grade perlite and medium grade vermiculite under intermittent mist using terminal stem cuttings prepared from current season growth treated with K-IBA (1000–5000 mg/l) using the quick-dip method (Thetford and others 2012).

While all 3 *Polygonella* species have visual characteristics that make them good candidates for wildflower landscape plantings, each has a different range within Florida. Little is known of the growth and flowering potential for these *Polygonella* species outside of their respective native ranges. A common-garden approach to landscape performance evaluation has been used to investigate adaptability of wildflower species to different regions of Florida and has demonstrated differences in performance for black-eyed Susan (*Rudbeckia hirta* L. [Asteraceae]), tickseed (*Coreopsis* L. spp. [Asteraceae]), blanket flower (*Gaillardia pulchella* L. [Asteraceae]), and other species grown in areas outside their native region (Norcini and others 2001a, 2001b; Hammond and others 2007; Czarnecki and others 2008). The common-garden experiment is a classic approach used to study genotype-by-environment interactions, by implementing the same design in different environments.

The overall objective of this study was to evaluate the establishment, growth, and flowering potential of vegetatively propagated *Polygonella* utilizing a common-garden approach within 3 regions of Florida.

MATERIALS AND METHODS

Each species was evaluated in landscape trials located in north (Milton), central (Gainesville), and south (Fort Pierce) Florida (Figure 3). At each site, raised beds were prepared, covered with semi-permeable landscape fabric for weed management, and plants were placed in-ground in rows with drip irrigation. Initial soil samples were analyzed and characteristics are presented in Table 1. Softwood cuttings of *P. macrophylla* (21 May 2008), *P. polygama* (21 May 2008), and *P. robusta* (14–15 August 2008) were collected from extant natural populations occurring within state parks in north or south Florida (Figure 3) and rooted in Fafard 3B in Milton, Florida. Finished plugs were

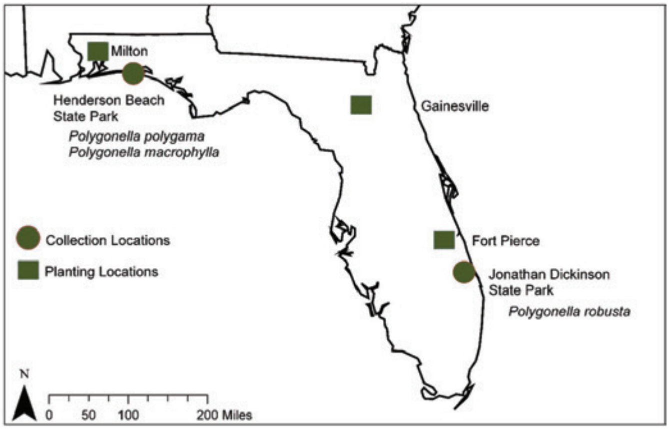

Figure 3. Cutting collection sites and trial planting sites for common-garden trials of 3 *Polygonella* species native to Florida.

transplanted into standard #1 (3.7 l) pots with soilless media (Fafard 3B) and top-dressed 2 wk later with 15 ml (1 Tbls) of Osmocote Plus 18N:2.6P:10K (18-6-12), 9-mo formulation (The Scotts Company, Marysville, Ohio). Plants were sensitive to overwatering during container production; hence, individual plants were hand-watered as needed based on the occurrence of minor wilting of stem tips. Finished plants for all 3 species were similar in size at the end of the production period when distributed to Gainesville and Fort Pierce and were planted 20 April 2009 at all 3 sites. Initial plant height (cm) and width (cm) (mean of 2 perpendicular measurements) and visual quality were recorded at planting.

Each month thereafter, the same individuals within each site recorded visual quality and flowering throughout the evaluation period based on the following criteria. Visual quality was based on a scale of 1–5, where 1 = Very poor quality–not acceptable, severe leaf necrosis or yellowing, not marketable, dead or almost dead; 2 = Poor quality–not acceptable, sparse/uneven form, leaf yellowing, unhealthy appearance, not marketable; 3 = Fair quality–marginally acceptable, somewhat desirable form and color, moderately healthy; 4 = Good quality–very acceptable, minor flaws, nice color without yellowing, good form, healthy and vigorous, marketable; and 5 = Excellent–perfect condition, premium color and form, extremely healthy and vigorous, very marketable.

Flowering was based on a scale of 1–5, where 1 = No flowers or flower buds; 2 = Flower buds visible, no open flowers; 3 = One to several open flowers; 4 = Many open flowers, average to good flowering; and 5 = Abundant flowering, possible peak bloom. Plant height (cm) and width (cm) (mean of 2 perpendicular measurements) were again recorded and a growth index calculated ([height +width1 + width2]/3) after 28 and 60 wk.

We obtained monthly average temperature (°C) and monthly total rainfall (cm) for 3 planting sites in northwest (Milton), central (Gainesville), and south (Fort Pierce) from

TABLE 1

Initial chemical and nutrient analysis of soils in north (Milton), central (Gainesville), and south (Fort Pierce) Florida where Polygonella were trialed.

Florida planting site	Organic matter (%)	Est. N release (kg/ha)	P (mg/l)	K (mg/l)	Mg (mg/l)	Ca (mg/l)	pH	EC (mmhos/cm)	CEC (meq/100 g)
North	1.3	78	20	17	7	110	5.3	0.01	1.1
Central	2.9	114	133	71	49	499	6.4	0.11	3.4
South	2.8	112	56	79	102	1132	5.9	0.08	8.6

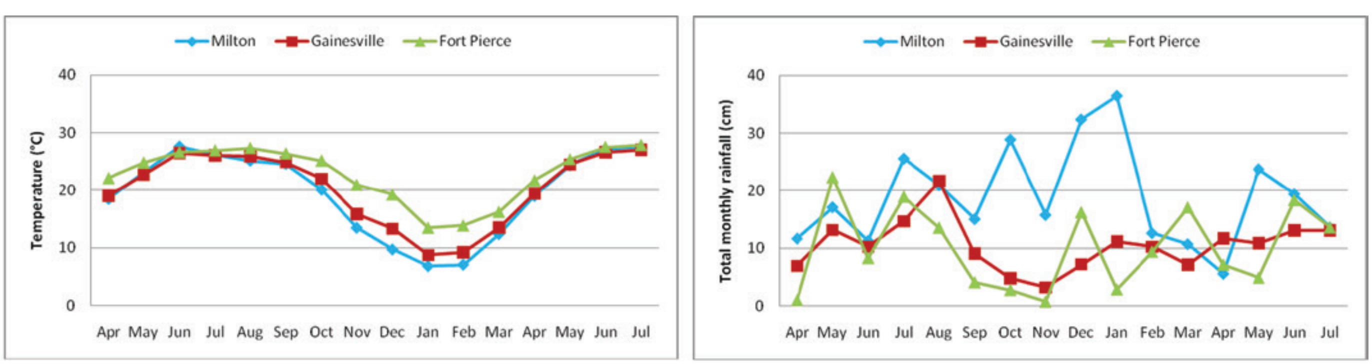

Figure 4. Monthly average temperature (°C) and monthly total rainfall (cm) for 3 planting sites in north (Milton), central (Gainesville), and south (Fort Pierce) Florida. We initiated the study on 20 April 2009 and terminated in July 2010.

the Florida Automated Weather Network (Figure 4). All plants were pruned while still dormant on 18 March 2010 by shearing plants to a height and width that removed all dead floral stems; plant height and width following pruning varied by plant based on the proportion of vegetative and floral stems present prior to pruning.

Experiment Design and Data Analysis

Landscape trials were planted in 3 locations: north (Milton), central (Gainesville), and south (Fort Pierce) Florida (see Figure 3). At each location, a randomized complete block design with 3 plants (subsamples) within each of the 3 blocks (raised bed) was installed. The 3 plant species were expected to perform differently from one another, and our primary interest was plant performance over locations; hence, we conducted statistical analysis independently for each species. Significance of main effects of location and week of evaluation and their interactions were determined independently for each species using PROC MIXED in SAS (version 8.01; SAS Institute, Cary, North Carolina) with a repeated statement included to account for the repeated measures data. When significant differences among main effects or their interaction were present, significant differences between means for an individual date were determined with the lsmeans procedure using a Bonferroni correction. Standard error bars demonstrate significant differences among locations within a given date. All differences were significant at an alpha level of 5%.

RESULTS

Soil characteristics at the 3 sites were typical of the 3 regions, with the north Florida soil having the least organic matter, which was half of the organic matter present at the central and south Florida soils. These differences in organic matter were also reflected in the cation exchange capacities of the 3 soils (see Table 1). Soil characteristics support the use of slow release fertilizer to manage soil fertility for these native plants adapted to low fertility plant communities of Florida.

All 3 *Polygonella* species outplanted successfully at each of the 3 Florida locations and survival exceeded 80% for all species at all locations by November 2008, which was 28 wk after planting (Figure 5). All 3 species had achieved their maximum size (Figure 6) and were expressing or just past peak flowering or peak quality ratings (Figure 7) by wk 28. Although all 3 species expressed similar peak periods of flowering and quality ratings, there were differences in performance between the species as well as differences in species performance among the 3 planting sites (Table 2). Most notable was the lack of persistence for *P. robusta* at all 3 sites beyond winter dormancy (Figure 5).

Quality ratings for *P. macrophylla* were initially greater in Milton and remained higher than other sites between August and November 2009, resulting in a significant interaction between the main effects of planting location and the week of evaluation (see Table 2; Figure 7A). Following winter dormancy, however, plant quality ratings did not differ among the sites in 2009, and quality ratings showed a general pattern of increase through July. Flowering followed a similar pattern with first flowers appearing between July and August and peak flowering occurring between October and November for all sites. Flower ratings for north Florida exceeded ratings for other sites from October to November, and flowers were present in north Florida only in May 2009 and no flowers were present after November 2009. Growth index did increase over time but did not differ among locations with a growth index of 16 at planting, 49 at the peak of flowering, and 32 just prior to flower initiation.

Quality ratings for *P. polygama* were initially greater in Milton (north) and Fort Pierce (south) until July 2009 when ratings for plants in north Florida remained higher than other sites until February 2010, resulting in a significant interaction

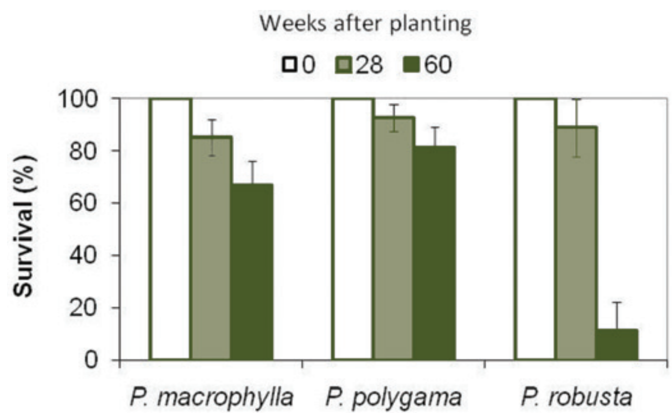

Figure 5. Mean survival (%) for 3 *Polygonella* species 0, 28, and 60 wk after planting (April 2009, November 2009, and July 2010, respectively) in north (Milton), central (Gainesville), and south (Fort Pierce) Florida. Error bars denote standard error of mean survival, *n* = 9.

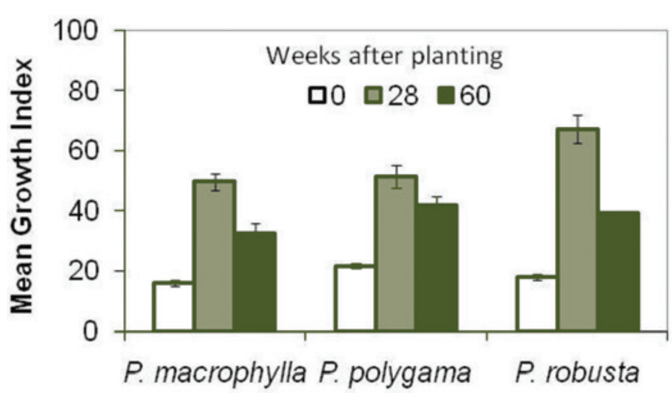

Figure 6. Mean growth index for 3 *Polygonella* species 0, 28, and 60 wk after planting (April 2009, November 2009, and July 2010, respectively) in north (Milton), central (Gainesville), and south (Fort Pierce) Florida. Error bars denote standard error of mean growth index, *n* = 9.

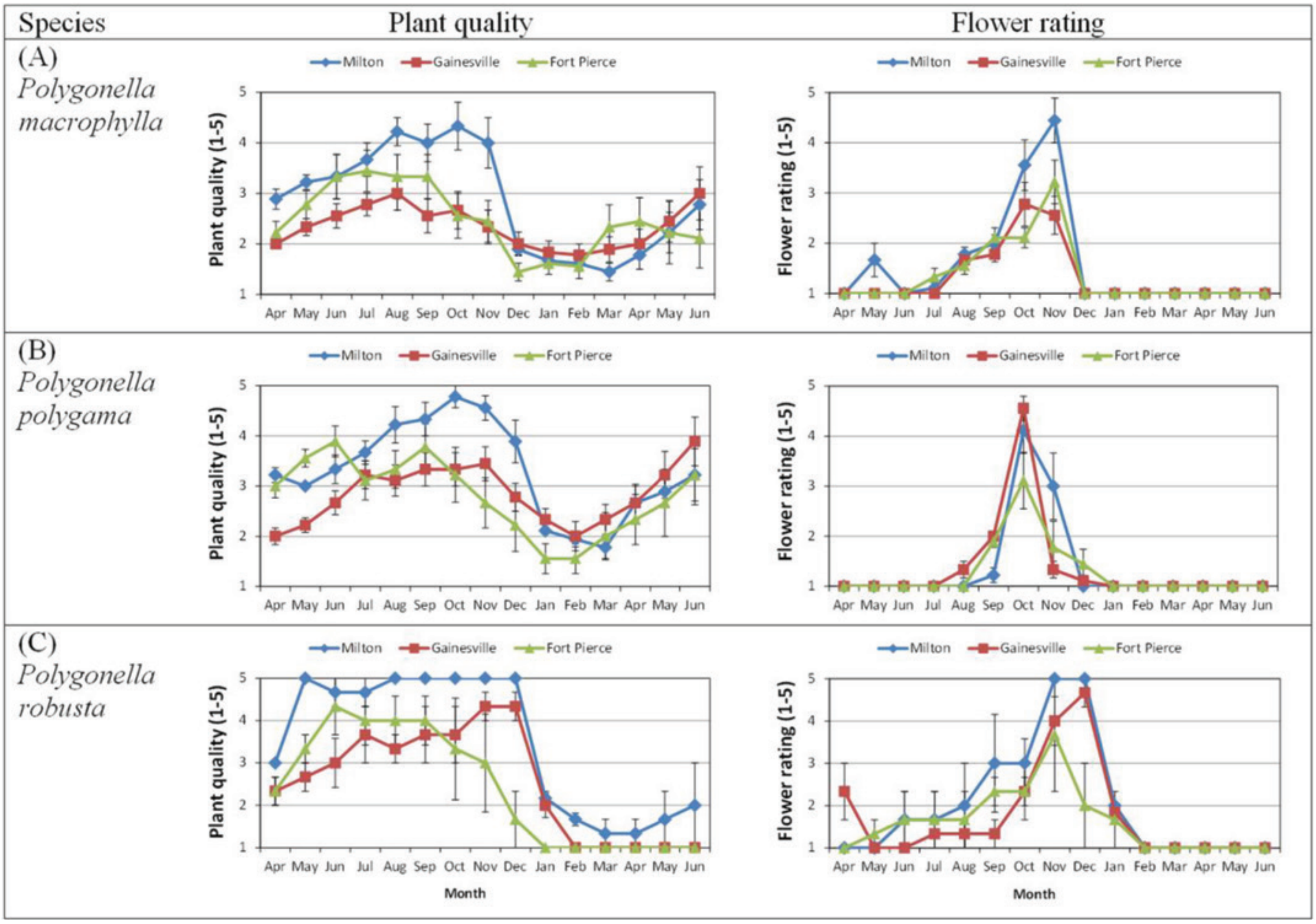

Figure 7. Monthly plant quality and flower ratings of *Polygonella macrophylla* (A), *Polygonella polygama* (B), and *Polygonella robusta* (C) planted in north (Milton), central (Gainesville), and south (Fort Pierce) Florida. We initiated the study on 20 April 2009 and continued through July 2010. Visual quality was based on a scale of 1–5, where 1 = Very poor; 2 = Poor; 3 = Fair; 4 = Good; and 5 = Excellent. Flowering was based on a scale of 1–5, where 1 = No flowers or flower buds; 2 = Flower buds visible, no open flowers; 3 = One to several open flowers; 4 = Many open flowers; and 5 = Abundant flowering, possible peak bloom. Error bars denote standard error of mean plant quality or flower rating, *n* = 9.

between the main effects of planting location and week of evaluation (see Table 2; Figure 7B). Following winter dormancy, however, plant quality ratings did not differ among the sites in 2010, and quality ratings showed a general pattern of increase from January through July. Flowering followed a similar pattern with first flowers appearing between July and August 2009 in north Florida and between August and September for central and south Florida. Peak flowering occurred in October for all sites, but flowering in north Florida exceeded flowering at both central and south Florida sites in November. Flowers were present on plants in central and south Florida while no flowers were present on plants in north Florida in January 2010, and no plants flowered from February to July of 2010. Growth index did increase over time but did not differ among locations with a growth index of 22 at planting, 52 at the peak of flowering, and 42 just prior to flower initiation.

Quality ratings for *P. robusta* were initially greater in Milton (north) until January 2010, resulting in a significant interaction between the main effects of planting location and week of evaluation (see Table 2; Figure 7C). Following winter dormancy, plant quality ratings remained low for Gainesville (central) and Fort Pierce (south) reflecting the 100% mortality at those 2 sites. A single plant survived in Milton and began to show signs of improved quality by July 2010. Flowering began early for *P. robusta* with first flowers appearing between April and May and reaching peak flowering from November to December. Flowering was most similar for plants in north and central Florida with the exception of a slight delay in flowering for plants in central Florida in September. Flowering for plants in south Florida was similar to other sites through November, but a considerable decline in flower ratings began in December. Flowering had stopped at all sites from March to July of 2010. Growth index did increase over time but did not differ among locations with a growth index of 18 at planting, 67 at the peak of flowering, and 40 just prior to flower initiation. In a similar common-garden trial of the same species produced from seeds, *P. robusta* performed as well as *P. macrophylla* and *P. polygama* (Wilson 2010).

TABLE 2

Type 3 tests of fixed effects of growth index, flowering, and plant quality of Polygonella *produced from wild-collected cuttings planted at 3 locations and evaluated over 60 wk.*

Source	Degrees of freedom		Type 3 F	Pr > F
	Numerator	Denominator		
Polygonella macrophylla				
Growth index				
Location	2	4	2.38	0.2084
Week	2	4	63.75	< 0.0009
Location x Week	4	8	1.56	< 0.2742
Flower rating				
Location	2	4	7.49	0.0444
Week	15	30	53.65	< 0.0001
Location x Week	28	56	4.01	< 0.0001
Quality rating				
Location	2	4	11.56	0.0218
Week	15	30	11.53	< 0.0001
Location x Week	28	56	1.88	0.0226
Polygonella polygama				
Growth index				
Location	2	4	1.18	0.3951
Week	2	4	36.33	< 0.0027
Location x Week	4	8	2.07	< 0.1767
Flower rating				
Location	2	4	2.45	0.2018
Week	15	30	51.10	< 0.0001
Location x Week	28	56	4.09	< 0.0001
Quality rating				
Location	2	4	12.09	0.0201
Week	15	30	11.70	< 0.0001
Location x Week	28	56	2.18	0.0066
Polygonella robusta				
Growth index				
Location	2	4	4.95	0.0828
Week	2	2	131.17	0.0076
Location x Week	2	3	6.01	0.0893
Flower rating				
Location	2	4	3.03	0.1582
Week	15	30	13.20	< 0.0001
Location x Week	28	56	1.52	0.0916
Quality rating				
Location	2	4	27.73	0.0045
Week	15	30	25.46	< 0.0001
Location x Week	28	56	1.87	0.0235

DISCUSSION

Results of the field experiment demonstrate the potential to successfully outplant container-grown *Polygonella* produced from wild-collected cuttings within all 3 regions of Florida. Plant quality ratings also indicate that the plants maintained a fair quality, would be marginally acceptable with a somewhat desirable form and color, and appear moderately healthy for a majority of the growing season within all 3 regions. Quality ratings also demonstrate a decrease in quality during the dormant season (December through April) when plants would be considered poor and not acceptable because of sparse/uneven form, leaf yellowing, or an unhealthy appearance and would not be considered marketable.

Planting location did have an effect on quality ratings for all 3 species, particularly during peak flowering. The consistently higher quality ratings for plants in Milton and the occasional higher quality ratings for plants in central Florida suggest north and central Florida would be more suitable locations for the landscape use of all 3 *Polygonella*. Milton (north) did experience greater rainfall and Fort Pierce (south) frequently experienced greater rainfall than did Gainesville (central); however, all trials were irrigated providing a similar minimal irrigation throughout the growing season. Temperatures were similar at all 3 locations until winter months, at which point lower winter temperature combined with the higher rainfall in December and January in north Florida may have contributed to the loss of *P. robusta*. Compared to north Florida, winter months are typically dryer and warmer in the central and southern regions of the state where *P. robusta* occurs in natural plant communities. Effects of provenance selection have been noted with other Florida wildflower species (Norcini and others 2001a; Hammond and others 2007; Czarnecki and others 2008). Lewis (1991) investigated detectable allozyme diversity of *P. macrophylla* and determined that most of the diversity of this species is among populations. This result suggests that several populations must be protected in order to preserve the genetic resources of *P. macrophylla*, and provenance origin should be considered in additional work where these plants would be used for ecological restoration projects. Further development of horticultural selections or comparison of plants from a variety of provenances may also result in varied or improved performance of these plants across the 3 regions of the state (Norcini and others 2001b; Czarnecki and others 2008).

ACKNOWLEDGMENTS

The authors are grateful for the help of Keona Muller, Pat Frey, Fé Almira, Darlene Bonelli, and Tim Baxley for their field and research assistance. We also thank Steve Woodmansee for his assistance in permitting and collection. Gabriel Campbell and Anna Dicks assisted with review of the final manuscript. Gratitude is extended to the Florida Wildflower Foundation for funding this research.

REFERENCES

Bissett N. 2010. Personal communication. Davenport (FL): The Natives Inc. Horticulturist, Restoration Ecologist, and Botanist.

Coile NC, Garland MA. 2003. Notes on Florida's endangered and threatened plants. Botany Contribution No. 38, 4th ed. (PDF version). Florida Department of Agriculture & Consumer Services, Division of Plant Industry. 122 p.

Czarnecki DM, Rao MN, Norcini JG, Gmitte FG, Deng Z. 2008. Genetic diversity and differentiation among natural, production, and introduced populations of the narrowly endemic species *Coreopsis leavenworthii* (Asteraceae). Journal of the American Society of Horticultural Science 133:234–241.

[FDEP] Florida Department of Environmental Protection. 2009. Fort Pickens Aquatic Preserve Information Page. URL: http://www.dep.state.fl.us/coastal/sites/ftpickens/info.htm (accessed 23 Feb 2009).

Hammond HE, Norcini JG, Wilson SB, Schoellhorn RK, Miller DL. 2007. Growth, flowering, and survival of fire wheel (*Gaillardia pulchella* Foug.) based on seed source and growing location. Native Plants Journal 8:25–39.

Heather A, Pérez H, Wilson S. 2010. Non-deep physiological dormancy in seeds of two *Polygonella* species with horticultural potential. HortScience 45:1854–1858.

Horton JH. 1963. A taxonomic revision of *Polygonella* (Polygonaceae). Brittonia 15:177–203.

Ingram D, Yeager T. 1990. Propagation of landscape plants. URL: http://edis.ifas.ufl.edu/MG108 (accessed 10 Jun 2009). Electronic Data Information Source, IFAS Extension, University of Florida.

Lewis PO. 1991. Allozyme variation in the rare gulf coast endemic *Polygonella macrophylla* Small (Polygonaceae). Plant Species Biology 6:1–10.

Lewis PO, Crawford DJ. 1995. Pleistocene refugium endemics exhibit greater allozymic diversity than widespread congeners in the genus *Polygonella* (Polygonaceae). American Journal of Botany 82:141–149.

Norcini JG, Aldrich JH, Martin FG. 2001a. Seed source effects on growth and flowering of *Coreopsis lanceolata* and *Salvia lyrata*. Journal of Environmental Horticulture 19:212–215.

Norcini JG, Thetford M, Klock-Moore KA, Bell ML, Harbaugh BK, Aldrich JH. 2001b. Growth, flowering, and survival of black-eyed Susan from different regional seed sources. HortTechnology 11:26–30.

Osorio R. 2001. A gardener's guide to Florida's native plants. Gainesville (FL): University of Florida Press. 345 p.

Taylor WK. 1998. Florida wildflowers in their natural communities. Gainesville (FL): University Press of Florida. 370 p.

Thetford M, O'Donoughue AE, Wilson SB, Pérez HE. 2012. Softwood cutting propagation of three *Polygonella* wildflower species native to Florida. Propagation of Ornamental Plants 12(1):58–62.

Wilson S. 2010. Personal communication. Gainesville (FL): University of Florida. Professor of Environmental Horticulture.

Wunderlin RP, Hansen BF. 2003. Guide to the vascular plants of Florida. 2nd ed. Gainesville (FL): University Press of Florida. 787 p.

Wunderlin RP, Hansen BF. 2009. Atlas of Florida vascular plants. In: Landry SM, Campbell KN, application development. URL: http://www.florida.plantatlas.usf.edu (24 Aug 2009). Florida Center for Community Design and Research, Institute for Systematic Botany, University of South Florida, Tampa.

AUTHOR INFORMATION

Mack Thetford
West Florida Research Education Center
University of Florida
5988 Highway 90, Building 4900
Milton, FL 32583
thetford@ufl.edu

Alison E O'Donoughue

Sandra B Wilson

Hector E Pérez

Environmental Horticulture Department
University of Florida
Gainesville, FL 32611