Harperocallis flava

Harper's beauty

5-Year Review:
Summary and Evaluation

Apalachicola National Forest, Liberty County
Photos by Vivian Negrón-Ortiz

U.S. Fish and Wildlife Service
Southeast Region
Panama City Field Office
Panama City, Florida

5-YEAR REVIEW

Harperocallis flava (Harper's beauty)

I. GENERAL INFORMATION

A. Methodology used to complete the review

This review was accomplished using information obtained from the Recovery Plan of June 1994, unpublished field survey results, reports of current research projects, peer reviewed scientific publications, unpublished field observations by Service, Forest Service, State and other experienced biologists, and personal communications. These documents are on file at the Panama City Field Office. In addition, a Working Recovery Group meeting, including those individuals working on and knowledgeable about the natural history of Harper's beauty, was held on July 14, 2015 to discuss past, current, and planned activities and their relationship to the recovery actions stipulated in the Recovery plan. Information from that meeting, including progress on certain recovery actions, new scientific data, management, has been incorporated into this 5-year status review. A *Federal Register* notice announcing the review and requesting information was published on September 23, 2014 (79 FR 56821). No part of this review was contracted to an outside party. This review was completed by the Service's lead Recovery botanist in the Panama City Field Office, Florida.

B. Reviewers

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C. Background

1. FR Notice citation announcing initiation of this review: 79 FR 56821 (September 23, 2014): Endangered and threatened wildlife and plants: 5-Year Status Review of 27 Southeastern Species.

2. Species status: Unknown (2010-2015). 14 forest sites were determined to be declining in size over a three-year study period (Kesler and Trusty (2012 unpubl. report); relatively stable for roadside permanent plots; unknown for other historical locations but the Forest Service

confirmed that they are 22 extant element occurrences (EOs); data on population trends or habitat conditions across the whole range of the species is lacking.

3. Recovery achieved: 2 (26-50% recovery objectives completed); see section II.B.3 for details on recovery criterion and actions, and how each action has or has not been met.

4. Listing history

Original Listing

FR notice: 44 FR 56862-56863
Date listed: November 1, 1979
Entity listed: species
Classification: Endangered

5. Associated rulemakings*:* Not applicable

6. Review History

Recovery Plan: September 14, 1993

Previous 5-year status review: Aug 8, 2009

Recovery Data Call: 2003 to 2009 (stable); 2010-2011 (unknown)

2012-2015: (1) unknown for Bay County population; (2) contrasting observations for Apalachicola National Forest (ANF): declining for 14 sites (based on a three-year study); relatively stable for roadside permanent plots; trends for other sites: unknown.

7. Species' Recovery Priority Number at start of review

The Harper's beauty is assigned a recovery priority of 7C because the degree of threat is moderate, it is a monotypic genus with high recovery potential, and is in conflict with development and growth.

8. Recovery Plan or Outline

Name of plan: Harper's beauty (*Harperocallis flava)* recovery plan
Date issued: 1983
Dates of previous revisions: N/A

II. REVIEW ANALYSIS

A. Application of the 1996 Distinct Population Segment (DPS) policy

The Act defines species as including any subspecies of fish or wildlife or plants, and any distinct population segment of any vertebrate wildlife. This definition limits listing DPS to only

vertebrate species of fish and wildlife. Because *H. flava* is a plant, the DPS policy is not applicable and not addressed further in this review.

B. Recovery Criteria

1. Does the species have a final, approved recovery plan containing objective, measurable criteria?

Yes. The recovery plan includes recovery objectives and measurable criteria for downlisting and delisting the species. For downlisting the species from endangered to threatened the goal is to have five populations, each with two colonies[1] or when there are three populations with three colonies each. Delisting requires a minimum of five secured (protected and managed) wild populations with a minimum of three colonies each in habitat similar to the 'type locality'[2] and away from the roadside. According to the recovery plan, the criteria of the minimal percent frequency and cover for each colony needs to be set and requires prior research.

2. Adequacy of recovery criteria.

a. Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat?

No. The recovery criteria were based on the available data at the time the plan was published 26 years ago.

b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)?

No. The recovery plan only addressed factors A-habitat destruction and modification, which is still a threat, B-overutilization for commercial, recreational, scientific, or educational purposes, and D-Inadequacy of existing regulatory mechanisms. See sections II.B.3 and II.C.2 for description of current information and threats.

3. List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information. For threats-related recovery criteria, lease note which of the 5 listing factors[3] are addressed by that criterion. If any of the 5-listing factors are not relevant to this species, please note that here.

The recovery plan lists downlisting (the goal is to have five populations, each with two colonies or when there are three populations with three colonies each) and delisting [to adequately protect

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[1] Colony: the recovery plan uses the term to indicate major clumping within a population.

[2] According to the Forest Service, current conditions at the type locality are poor and are not a good reference for restoration goals.

[3] A)Present or threatened destruction, modification or curtailment of its habitat or range;
B) Overutilization for commercial, recreational, scientific, or educational purposes;
C) Disease or predation;
D) Inadequacy of existing regulatory mechanisms;
E) Other natural or manmade factors affecting its continued existence.

and manage five secured wild populations with a minimum of three colonies each having been either found or established in habitat similar to the type locality (see footnote 2) and away from the roadside] criteria. These recovery criteria address factors A, B, and D. Currently, factors A, D, and E are relevant for this species; factors B and C are not relevant to *H. flava*.

We summarize our progress below under existing recovery actions. Recovery action 1 addresses factor D; recovery actions 2-5 address factor A; and recovery action 6 addresses factor B.

Note: The term 'colonies' should be replaced with the word 'clones'. The number of colonies/clones is difficult to determine in the field without a genetic assessment.

1. Protect habitat and existing colonies of Harper's beauty

1.1. Secure sites on Forest Service lands

To date, about 27 protected EOs[4] have been secured at Apalachicola National Forest (ANF), Liberty and Franklin Counties. The ANF land is federal property and is therefore protected under the Endangered Species Act (Act).

1.2. Encourage the State to list Harper's beauty

This action has been met. Harper's beauty was listed as endangered by the State of Florida in 1991 (D. Weaver, 2009, pers. comm. to M. Jenkins, Florida Division of Plant Industry).

1.3. Secure sites on State right-of-ways

A large population of *H. flava* occurs in ANF SR 65 ROW. This roadside population is protected by the Forest Service, but is subjected to impacts when road maintenance occurs. A management agreement has been in place since 1992 for *H. flava* area, a 10 mile-segment in SR 65. The Plan was updated in 2015.

1.4. Secure sites on other lands

This action has not been met. The population on privately owned land in Bay County is not protected and conservation measures (e.g., conservation easement, land acquisition) are needed for the recovery of the species.

2. Conduct searches for new colonies

This recovery action is ongoing and conducted primarily by the Forest Service, FWS botanist, and Florida Natural Areas Inventory (FNAI).

[4] Element Occurrence (EO): an area of land and/or water in which a species or natural community is, or was, present. For species, it corresponds with the local population (portion of a population or a group of nearby populations). It is also referred to as occurrence, location, or site.

3. Preserve existing germplasm

This action has been partially met. The Historic Bok Sanctuary (Bok Sanctuary), Lake Wales, Florida, possesses 835 seeds in storage (416 in ambient conditions and 419 refrigerated) from a total of 1,312 seeds obtained from seven capsules collected in 2006 and 2007 by L. Keppner (Peterson and Campbell 2007) from the private owner of the Bay County population (L. Keppner, 2009, pers. comm.).

A pollen bank has not been initiated. Cryopreservation of pollen, a simple method of long-term pollen storage, from unique genotypes and clones identified by the 2015 genetic study is recommended.

4. Establish additional colonies

This action has been initiated as an experimental reintroduction (Walker 2015, unpubl. report; recovery action 5.1).

5. Monitor and manage colonies to assist and maintain recovery

This action has been partially met. See below activities.

5.1 Collect baseline data

Current populations have been mapped primarily by FNAI, the U.S. Forest Service (Forest Service), and the U.S. Fish and Wildlife Service (Service), and the following baseline data have been collected:

Seed ecology studies

2015: Dr. Pérez and graduate student, Ms. Amber Gardner, of Univ. of Florida are currently estimating patterns of viable seed production; germination ecology; and desiccation tolerance of *H. flava* seeds. Specifically, they aim to determine the seasonal timing of germination and ability of *H. flava* to form soil seed banks, and whether seed viability is a limiting factor in recruitment and the ability to store seeds under genebank conditions.

2007: Germination studies were conducted at Bok Sanctuary from seeds collected in 2006 and 2007 (Peterson and Campbell 2007). Of the 1,312 seeds, 477 were used in the seed experiments following Wagner and Spira's (1996) germination protocol. Fifty-one percent of the seeds collected in 2007 germinated, while no germination occurred for the seeds collected in 2006. No additional work was pursued in 2008 (Campbell, Bok Sanctuary, 2009, pers. comm.).

1996: Wagner and Spira's (1996) preliminary germination trials indicated that seeds are not dormant when they mature. Germination was high from freshly collected seeds grown at 21/10°C conditions and increased with cold stratification. However, Perez and Gardner (2015 pers. comm.) seed study suggests morphological dormancy: the embryo seems underdeveloped at shedding and must grow within the seed prior to germination.

Demography

2009-2012: Kesler and Trusty (2012 unpubl. report) studied 14 *H. flava* roadside and interior ANF populations. According to the study:

- The forest populations were determined to be declining in size over the study period: with $\lambda = 0.96$, in 20 years, only 44% of plants were predicted to remain. Survivorship was lower for roadside marked plants.

- The authors did not observe seedlings of *H. flava*.

- They observed some roadside populations with patches of plants up to 0.5 m in diameter. This is consistent with clonality, an asexual mode of reproduction depicted by von Wettberg et al. (2015 unpubl. data) genetic study. Thus, clonal propagation through offshoot ramets is a prevalent maintenance and growth mechanism for *H. flava* populations.

  For habitat and fire observations see section *5.4: Determine effective management options and implement them*; and for roadside widening activities recommendations see section 2, Factor A (Present or threatened destruction, modification or curtailment of its habitat or range)

2005: Walker and Silletti (2005) studied the population dynamics of *H. flava* in ANF for three years. The authors described the ramet size, reproductive status, and mortality and recruitment rates. Six sites were selected, ≥ 3 permanent plots/site were established totaling about 300 ramets/site, and individual ramets were marked. The total number of ramets declined from year to year. Larger ramets were more likely to produce reproductive structures, but the number of reproductive ramets was low and varied with site and year. Small ramets suffered higher mortality. Low recruitment and high mortality suggested that populations were declining possibly due to a decrease in precipitation. The authors observed crayfish induced ramet mortality but the effect of their activity at larger scales is unknown. Therefore, we do not have enough data for developing effective monitoring and management strategies for *H. flava*.

Genetics: Genetic studies were conducted by Godt et al. (1997) and von Wettberg et al. (2015 unpubl. data); see section II.C.1.b. for more information.

Experimental Reintroduction: Walker (2015, unpubl. report) tested the success of reintroducing plants to several sites within the ANF using SR 65 roadside populations as source material. Except in one wet habitat, survival exceeded 90%. Specific observations: small or large plants as well as flowering vs. non-flowering plants survive transplantation; habitat quality (water quantity and seasonal patterns of surface flow or inundation) and the timing of relocation are important for survival. Overall, transplanting Harper's beauty may be

a viable recovery strategy, but the strategy could be labor intensive, and may be most effective for smaller scale objectives.

5.2 Conduct autoecological research

5.2.1. Identify pollinators or vectors of dissemination

Pitts-Singer et al. (2002) studied the pollinator-plant relationship at two sites located on the ANF. The authors observed five insect species visiting the flowers, but only halictid bees gathered pollen from the flowers. According to the pollination study conducted by Wagner and Spira (1996), selfing might be the main reproductive mechanism for *H. flava*; this would explain the low of genetic diversity (see section II.C.1.b). Therefore, pollinator services may not be necessary for this species, but the flowers' pollen may be a food resource for the bees.

5.2.2. Identify limiting factors

Harper's beauty has an extremely narrow distribution. The Florida Department of Environmental Protection ranks this species as FACW, indicating Harper's beauty is a facultative wetland species (i.e., usually occurs in wetlands but may be found occasionally in uplands). Soils in these habitats are hydric, generally high in sand and peat, and strongly acidic. *H. flava* typically occurs in the ecotone between flatwoods and wetlands, so the soils may be transitional as well (J. Drake, Forest Service 2016, pers. comm.). About 85 to 98% of herb bog habitat has been estimated to be lost (Folkerts 1982); consequently, the rarity of this species' habitat is a limiting factor.

Harper's beauty occurs in fire-prone habitats. Walker and Silletti (2005) suggested that fire might be important for promoting growth and fecundity by increasing availability of nutrients and light. Lack of fire, or reduced fire frequency, and subsequent growth of shrubs and saplings in the understory, reduces *H. flava* abundance in areas where it was previously at high density (Negron-Ortiz, 2007, 2010, 2014, pers. observ.).

Seed germination and seedling establishment are not understood. If matured ovules lack dormancy (Wagner and Spira 1996), perhaps a persistent seed bank is not present, and if the established individuals are eliminated, a population cannot re-establish itself.

Clonal reproducing plants are associated with a low frequency of sexual recruitment. Low levels of recruitment from seed may reduce the availability of compatible mates affecting the genetic makeup of this species. Considering the low number of individuals with unique genotypes (von Wettberg et al. 2015 unpubl. data), the availability of compatible genotypes limits the likelihood of sexual reproduction.

5.3. Monitor colonies

Kesler and Trusty (2012 unpubl. report) studied 14 *H. flava* roadside and interior ANF populations for a period of three years. An additional three-year monitoring study was conducted by Walker and Silletti (2005) (for details see recovery action 5.1). Also, the

Forest Service (FS) established three permanent plots in 2000 and the number of flowering stems had been recorded for almost 11 years. Forest Service and FNAI biologists revisited 144 locations between 2012-2015 and found *H. flava* in 70 sites; also they established 24 roadside permanent plots in 2013.

5.4 Determine effective management options and implement them.

This recovery action is ongoing.

Management/general monitoring in ANF:

Management is an ongoing action conducted by the Forest Service. The ANF has a yearly 120,000^{+} acre prescribed burning program (L. Kirn, former Forest Service ecologist, 2009, pers. comm.). According to Forest Service staff, two to three compartments with Harper's beauty are burned annually during the growing and dormant seasons.

The Forest Service has field data and photos related to habitat condition for all of the EOs, and several EOs have multiple plots. They have a total of 71 field plots with habitat conditions quantified and Harper's beauty flowering stems counted at least one time (J. Drake, Forest Service ecologist, 2016, pers. comm.).

2009-2012: Kesler and Trusty (2012 unpubl. report) studied 14 *H. flava* roadside and interior ANF populations. According to the study:

- Optimal habitats were recommended to be those with high sun intensity but not burned too frequently as **fire reduces plant survivorship** and **recruitment the year of a burn**. Although they recommended a longer fire frequency interval, based on consensus, we recommend a 2-year fire frequency interval. Forest Service and FNAI biologists (2016, pers. comm.) indicated that a long-term fire frequency will promote growth of shrubs, particularly encroachment of *Cyrilla racemiflora* L., (swamp titi) and saplings in the understory, inhibiting *H. flava* emergence.
- The authors recommend not using solely flowering data to determine if a population is growing or declining through time. Flowering percentages are low, and plants can survive and asexually reproduce for years without ever flowering.

Management of ROW:

Mowing is a common practice to maintain rights-of-way (ROWs) in Florida, and the Florida Department of Transportation (FDOT) has implemented a program of reduced mowing along state highways in order to decrease costs for maintenance roadsides and to encourage the growth of native wildflowers (Keppner, Keppner Biological Services, 2009, pers. comm.). Apalachicola National Forest SR 65 is under a restrictive mowing schedule due to the occurrence of the Harper's beauty within the ROW. Protective measures such as restricting the amount of area and timing of mowing were established in the early 1990s and 2015 to: allow seeds to mature and disperse, maintain open habitat by mowing which mimics natural fire regime, prevent occurrence of invasive plants, and provide for visibility and highway safety.

In addition to mowing restrictions, the Forest Service only allows spot treatment application of herbicide in the ANF to control invasive and exotic species.

6. Determine appropriate means of public education

This action has not been initiated.

C. Updated Information and Current Species Status

1. Biology and Habitat

a. Abundance, population trends

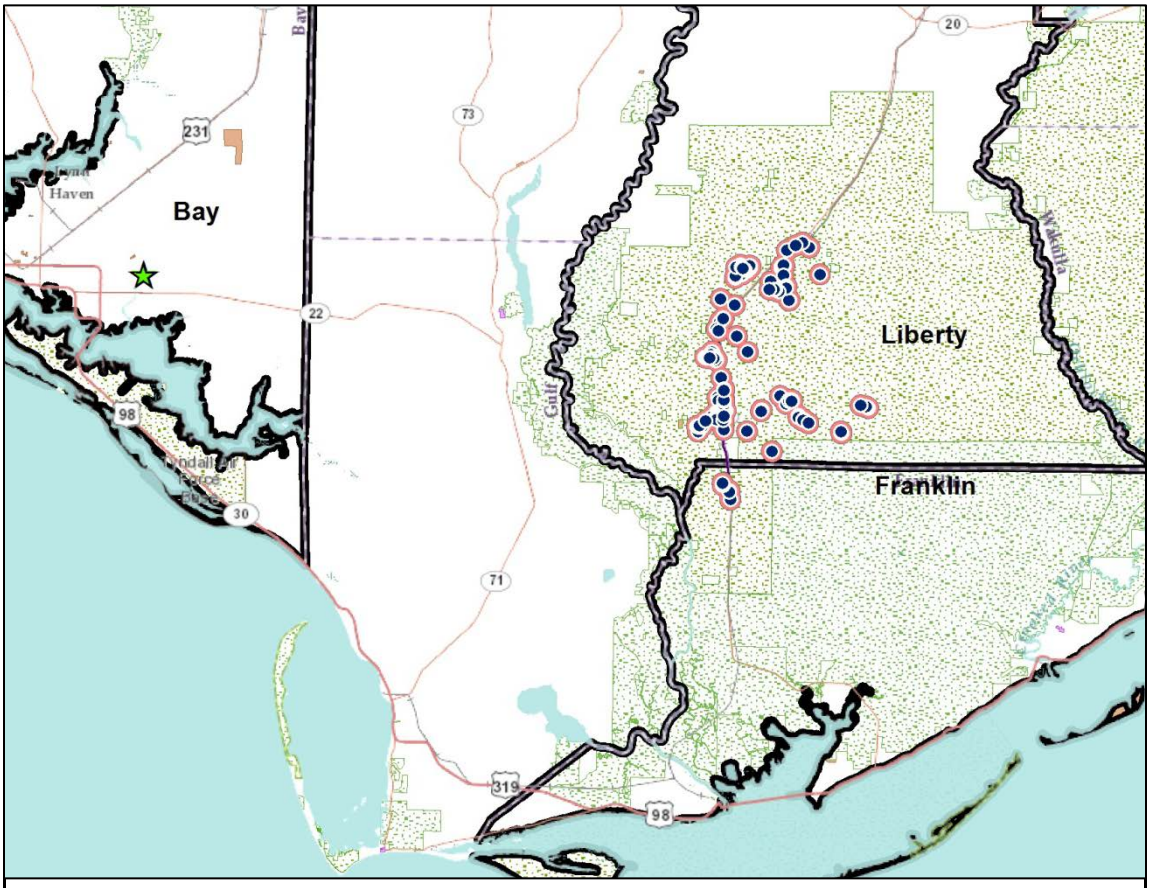

Fig. 1. Locations of *H. flava* (blue dots) in Bay, Franklin and Liberty counties, Florida. ★ = Bay County population; ▭ = Florida Conservation lands.

Harperocallis flava is endemic to the Florida Panhandle, and occurs in Bay, Franklin, and Liberty Counties (Fig. 1). Currently, 23 EOs are known extant in these three counties. Several locations appear to be extirpated by development, and/or habitat modification (USFWS 1983). Because surveys were conducted irregularly, with most sites visited only once, we have poor information regarding trends.

Table 1. Number of *Harperocallis flava* historical locations and current EOs. *only 23EOs are extant.

Site	1965-2008		2008-2015		Public/ Private ownership
	Historical locations	# EOs	Historical locations	# EOs	
Bay	1	1	1	1	Private
Franklin	2	1	9	2	Public
Liberty	19	16	135	25	Public
Total	22	19	145	*28	

Apalachicola National Forest (Franklin and Liberty Counties)

There are about 144 historic locations within ANF (Liberty and Franklin counties; Table 1), but points that are within 1 km should be associated with one EO (FNAI 2008, pers. comm.). Using that criterion, these 144 locations comprise about 27 EOs (FNAI 2015, pers. comm.; Table 1). Following FNAI's recommendation, 22 EOs are considered extant; three of the 22 EOs were found in excellent conditions, with hundreds to thousands of flowering stems. The remaining 5 historic EOs have presumably been extirpated. These occurrences are protected and managed by the ANF

Forest Service and FNAI biologists visited 132 of the 144 historic ANF locations between 2012-2015, and counted 3,704-11,273 flowering stems. Thirty locations were newly documented in 2014-2015, which resulted in seven new EOs. After this survey, 20 EOs are known extant in Liberty County. One of the EOs newly documented in 2015 was the first location reported east of the New River. A variable number of flowering stems were observed for 24 SR 65 roadside plots established by the Forest Service in 2013; the three-year counts estimated more than 2,000 flowering ramets Although the reported number of flowering stems were actual counts, the total plant abundance might be underestimated since sterile or non-flowering plants are considered to be the standard (Kesler and Trusty 2012, unpubl. report).

The Franklin County site represents the type locality. Nine locations have been documented for this site, but several locations are within 1 km (J. Drake, Forest Service 2016, pers. comm.); therefore, two EOs are considered to be present in Franklin County (Table 1). No populations of Harper's beauty were found on a 2008 survey conducted in the northwest portion of Tate's Hell State Forest (FDF 2008).

The *H. flava* sites are comprised of multi-clones and plants with unique genotypes (von Wettberg et al. 2015 unpubl. data). Notably, the SR 65 roadside population is comprised of unique multi-clone assemblages and distinctive genotypes (ANF compartment 77). Forest Service compartment no. 80 contains a group of plants with several unique genotypes. The individuals of each clone and those with unique genotype are found widely scattered and tended to display an intermingled distribution. This strategy, where additional individuals with the same genotype (i.e. independent clonal units) are scattered across the landscape, is expected to reduce the chance of death for any individual genotype. However, clonal reproduction could significantly reduce the effective

population size and consequently may enhance the magnitude of drift. In addition, the clonal-unit life span is unknown.

Private Land, Bay County

Only one population on private land has been reported for Bay County. It was first observed in 2003, and surveyed in 2006 and 2007 (Keppner and Anderson 2008). The authors observed a 61% decline in the number of ramets during the surveyed years (from 115 to 70 ramets) possibly due to drought, a dense mid-story, human error during surveying, or other unknown factors. This population is not protected and conservation measures are needed for the recovery of the species. Access to conduct surveys in subsequent years was denied by the landowner to the FWS botanist and other biologists.

Potentially, this species may occur in other counties, but fire suppression and lack of access and survey efforts likely explain the present distribution.

b. Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.)

Based on microsatellite analyses and the whole genome resequencing, von Wettberg et al. (**2015** unpubl. data) reported low levels of genetic diversity, and substantial amount of clonal reproduction for *H. flava* in ANF; but not all individuals were genetically identical. Seven microsatelite loci suggested 40 distinct multilocus genotypes among 60 individuals across the entire range; 31 individuals had displayed unique profiles, and 29 individuals shared 10 multilocus genotypes. Data revealed two shared mulitlocus genotypes in forest interior populations (across distinct populations) and eight shared genotypes on the roadside. The spatial distribution of individuals of each clone intermingled with other clones and those with unique genotypes.

Godt et al. (**1997**) examined genetic diversity in 464 individuals collected from ANF seepage bogs and roadside ROW. The authors found no discernable genetic variation between or among the populations; the species was monomorphic for the 22 loci scored. The lack of allozyme variation was explained by the possibility that the progenitors of *H. flava* had limited genetic diversity and/or that the species may have gone through several bottlenecks during its evolutionary history.

c. Taxonomic classification or changes in nomenclature:

Kingdom:	Plantae
Division:	Magnoliophyta
Class:	Liliopsida
Order:	Alismatales
Family:	Tofieldiaceae
Genus:	*Harperocallis*
Species:	*flava* McDaniel
Common name:	Harper's beauty

Harper's beauty is a grass-like perennial plant that blooms from mid-April through May, with fruits maturing in July. The leaves are basal and narrow, and the yellow flowers are solitary, perfect, and born on a stalk much longer than the leaves. The flowers consist of six tepals that are 9 to 15 mm long and become green when the plant is in fruit, six stamens, and a superior ovary with 3 to 4 carpels. It reproduces both sexually via seeds and asexually via rhizomes. No controversial taxonomic or nomenclatural problems exist since it is monophyletic (Tamura et al. 2004).

Initially, *H. flava* was described as a monotypic genus (McDaniel 1968). But on the basis of molecular and morphological evidence, it was expanded to include ten species native to the Guianas and the northern Andes formerly placed in the genus *Isidrogalvia* (Campbell and Dorr 2013).

The Angiosperm Phylogeny Group (APG) revised and updated the classification for the families of the flowering plants (APG II 2003). The APG II classification system assigned many of the Liliaceae (family that Harper's beauty belonged prior to the new taxonomic classification) to different families based on genetic relationships; however, many scientists still use Liliaceae *s.l.* rather than the APG system. The APG II transferred Harper's beauty to the Tofieldiaceae, a family now composed of four genera and embedded in the clade of Alismatales (Tamura et al. 2004).

d. Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g. corrections to the historical range, change in distribution of the species' within its historic range, etc.):

Originally, the Recovery Plan (1983) reported the species for Liberty County. Since then, the geographic distribution has extended to Franklin and Bay Counties (FNAI 2008, Keppner and Anderson 2008). In addition to the geographic distribution, the number of populations (i.e., EOs) has increased from three to 29 (Table 1; USFWS 1983, FNAI 2008, L. Kirn, unpubl. data) due to better surveys. Most EOs occurs inside ANF.

e. Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

Harper's beauty occurs on gentle slopes, seepage savannas between pinelands, and cypress swamps to open roadside depressions. It has been observed growing in pine flatwoods bog areas surrounded with swamp titi (*Cyrilla racemiflora)*, wiregrass (*Aristida stricta*), and slash pine (*Pinus elliottii*); along roadsides, and in damp roadside ditches adjacent to planted pines near flatwoods. Typically, this species occurs in wet prairies, in transitions to wetter shrub zones and roadside ditches. Wet prairie is characterized as a treeless plain with a sparse to dense ground cover of grasses and herbs, and dominated by wiregrass in the ANF. Wet prairie occurs on low, relatively flat, poorly drained terrain of the coastal plain, which is seasonally inundated or saturated for 50 to 100 days each year and burns every 2 to 4 years (Jenkins et al. 2007).

2. Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

The primary threat to these plants is the adverse modification of its habitat: industrial forestry practices, fire suppression, and soil and hydrological disturbances. In addition, this species is threatened by its very limited range and small population number.

a. Present or threatened destruction, modification or curtailment of its habitat or range:

Industrial forestry practices and residential/commercial development

The timber industry in North Florida became well established in the 1850s (FNAI 2005). Privately owned companies farm trees for timber and byproducts by mechanically preparing the site for planting, planting seedlings, and mechanically harvesting the trees typically by thinning and later clear cutting the site; then the process is repeated. These activities may reduce flora diversity, introduce exotic species and result in local extinction of native forest flora (Newsmaster et al. 2007).

The St. Joe Timberland Company (Timberland Company) is currently the largest timber company in the eastern region of the Panhandle with over 450,000 acres in silviculture, plus several other timber companies operate in the Panhandle. The timber industry is currently thriving and there is no indication that it will decline in the foreseeable future. In 2013, the Timberland Company sold more than 380,000 acres of its land to AgReserves, Inc., a tax-paying company owned by the Mormon Church. The land sold, which will maintain timber and agriculture uses, included lands in Bay, Calhoun, Franklin, Gadsden, Gulf, Jefferson, Leon, Liberty and Wakulla counties. The species now occurs on AgReserves, Inc.-owned property in Bay County, Florida, and this property may be utilized for timber and agriculture production. Therefore, tree farming remains a threat to this species.

In addition to being one of the largest private landowners in northwest Florida, the Timberland Company is also one of the largest real estate operating companies in the Southeast. This company develops both residential and commercial properties along roadways and near or within business districts in the region. Urbanized land in Florida, statewide, is projected to double by 2060 along with doubling of the population to 36 million (http://www.1000friendsofflorida.org/connecting-people/florida2060/). Because of lack of access and survey effort, there may be sites within these silvicultural lands that could support this species but have not yet been identified. Given the human population increase and proximity of these lands to established population centers in Bay County, residential or commercial development is a threat.

Fire suppression

Suppression of fire continues to threaten the pineland and savanna's flora as fire is an important factor in the maintenance of flatwoods (Abrahamson and Hartnett 1990). Fire influences community structure and composition (Abrahamson and Hartnett 1990), and with insufficient frequency in longleaf pine communities, a woody midstory quickly develops (Glitzenstein et al. 1995), negatively affecting the understory diversity. Several studies have shown that frequent prescribed fire regimes are important for maintenance of flatwoods diversity (Hiers et al. 2007). Lack of fire, and subsequent growth of shrubs,

and encroachment of swamp titi and saplings in the understory, inhibits this species emergence (Negrón-Ortiz, 2008, pers. observ.; FNAI 2008), reducing its abundance in areas where it was previously observed in great quantities (FNAI 2008). Furthermore, heavy shrub encroachment reduces the herbaceous ground cover in general, making it more difficult to applied prescribed fire. Therefore, frequent (every 2-4 years) prescribed burnings are needed to maintain optimal habitat for *H. flava* populations.

Road widening/Infrastructure improvements

Many *H. flava* plants are found along ANF SR 65. SR 65 is a major north-south corridor through ANF and it was recently improved by repairing or replacing culverts, elevating pavement, and widening travel lanes. While there are no current plans to increase the road capacity from two to four lanes, it remains a likely future scenario as SR 65 is an important hurricane evacuation route from the Gulf Coast. Roadside widening activities using heavy equipment or any soil disturbances to the right-of-way locations negatively impact plants (Kesler and Trusty 2012, unpubl. report). Construction activity may directly kill individual plants or convert habitat to unsuitable space; widening may convert native habitat to managed roadside; and culvert modification may change drainage patterns, which may change seasonal hydrology. Therefore, road widening and new roads continue to pose a threat to the species from habitat loss.

b. Overutilization for commercial, recreational, scientific, or educational purposes:

The Recovery Plan identified this as a threat to *H. flava*. Specifically, the Plan suggested that this species is of interest to lily enthusiasts due to its uniqueness, restricted distribution, and occurrence along the roadsides. Currently, there is no evidence to suggest that this factor is a threat.

c. Disease or predation:

There is no evidence to suggest that this factor is a threat.

d. Inadequacy of existing regulatory mechanisms:

Section 7(b)(4) and 7(b)(2) of the Act generally do not apply to listed plants species. However, limited protection of listed plants from take is provided to the extent that the Act prohibits the removal and reduction to possession of federally listed threatened and endangered plants or the malicious damage of such plants on areas under federal jurisdiction, or the destruction of endangered plants on non-federal areas in violation of state law or regulations or in the course of any violation of a state criminal trespass law.

While the Act requires federal agencies to carry out programs for the conservation of endangered and threatened species, no such programs are stipulated for private landowners. The Act does not provide for protection of plants on private lands as long as the activity is permissible under state/local laws. The State requires permission of private landowners for collecting of state-listed plants from their property.

Harperocallis flava is protected under Florida State Law, chapter 85-426, which includes preventions of taking, transport, and the sale of the plants listed under the State Law. The rule Chap. 5B-40, Florida Administrative Code, contains the "Regulated Plant Index"

(5B-40.0055) and lists endangered, threatened, and commercially exploited plant species for Florida; defines the categories; lists instances where permits may be issued; and describes penalties for violations (http://www.virtualherbarium.org/EPAC).

The Bay County Code of Ordinance (Chapter 19- Environmental Standards), under sections 1907 and 1909, provides restrictions, constraints and requirements to protect and preserve designated habitat conservation areas for rare, threatened, or endangered species, and wetlands (http://www.municode.com/Resources/gateway.asp?pid=14281&sid=9). Franklin and Liberty Counties do not have such regulations.

Harperocallis flava occurs in ANF SR 65 ROW. Highway ROW maintenance activities are not always reviewed for threatened and endangered species impact. However, if there is an activity (e.g., construction, mowing, or maintenance projects) affecting protected species, then the Service can recommend consultation to the FDOT under the Act. The FDOT routinely consults with the Service on all major road construction activities. Consultation should conform to specifications and coordination between FDOT, the Service, and the Forest Service. Also for any project on the forest that might affect their habitat (or plants specifically) the Forest Service do consult (informally or formally) with the Service.

Currently, Federal, State, and County regulations do not provide adequate protection.

e. Other

Crayfish activity wasn't a threat at the time the Recovery Plan was written. However, while conducting their demographic study, Walker and Silletti (2005) observed that crayfish mounds and chimneys buried many ramets. At the end of the three-year demographic study, ramet mortality was significantly higher in bog sites (22.2%) than in shrub sites (3.6%). Therefore, crayfish activity may pose a threat to the species.

Climate change

At present, fish, wildlife, and plants are also threatened by climate change. According to the Intergovernmental Panel on Climate Change Report (IPCC 2013), warming of the earth's climate is "unequivocal," as is evident from observations of increases in average global air and ocean temperatures, increases in concentration of greenhouse gases, widespread melting of snow and ice, and rising sea level. Scientific evidence indicates a rapid and abrupt climate change, rather than the gradual changes that have been currently forecasted (IPCC Report 2007), posing a significant challenge for fish, wildlife, and plant conservation. As climate changes, the abundance and distribution of the species also change. Highly specialized or endemic species are likely to be most susceptible to the stresses of changing climate. Species that are already rare may become rarer. This may be even more pronounced for those species with restricted ranges, with poor dispersal ability, requiring long generation times, possessing susceptibility to extreme conditions (such as flood or drought), exhibiting extreme habitat/niche specialization, or requiring symbiotic relationships (Hawkins et al. 2008).

Being endemic to Florida, *H. flava* has a restricted range; therefore it is potentially at risk, specifically since Florida is one of the areas most vulnerable to the consequences of climate change. Using the NOAA Sea Level Rise (SLR) and Coastal Flooding Impacts Viewer (https://coast.noaa.gov/slr/), the projections indicated potential impact to both known *H. flava* EOs in Franklin County by intrusion of saltwater beginning at one foot SLR.

D. Synthesis

Harper's beauty was described in 1968 and placed on the federally endangered species list in 1979. It is endemic to the Florida Panhandle, and occurs in open pineland bogs and along roadside ditches of Bay, Franklin, and Liberty counties. The main threat for this species is habitat destruction or modification (i.e., urban development, timbering, and inadequate fire management).

This species occurs in fire-prone habitats. Lack of fire, or reduced fire frequency, and subsequent growth of shrubs and saplings in the understory, reduces *H. flava* abundance in areas where it was previously at high density. Where fire management is implemented, it stimulates the emergence of individuals and maintains healthy, stable populations. No problems have been detected with disease or predation, but crayfish activities at the ANF populations may poses a threat to this plant.

The species occurs on both private and public lands. The populations at ANF are protected and adequately managed. A comprehensive population survey based on number of flowering stems was carried out to update the current EOs. Informal consultation has resulted in minimizing impacts from infrastructure development, specifically for ANF SR 65. FDOT's SR 65 ROW Vegetation Management Plan was updated in 2015 with a focus on avoiding and minimizing impacts to Harper's beauty. The population on privately owned land in Bay County is not protected and conservation measures are needed for the recovery of the species.

Harperocallis flava continues to meet the definition of an endangered species as a result of habitat destruction or modification and the effect of this threat in this plant's present narrow distribution. The recovery criteria for *H. flava* indicates that the species could be considered for 1) downlisting: when five populations, each with two colonies or when three populations have three colonies each, or 2) delisting: when a minimum of five secured (protected and managed) wild populations with a minimum of three colonies each have been either found or established in habitat similar to the type locality and away from the roadside. We consider this a conservative number of populations needed for recovery. Currently, there are 28 EOs with 23 of those populations being extant and 22 secured.

The extant populations of *H. flava* have low levels of genetic variation and exhibit a substantial amount of clonal reproduction. Therefore, *H. flava* lacks the genetic variation to cope with or adapt to different environmental pressures, and the populations have a greater risk of extinction or extirpation if the environment changes. Also the life span of these clonal units is unknown. Therefore, location of additional populations outside the ANF is a priority, as this may lead to the discovery of new genets.

According to the recovery plan, the criteria for establishing the minimal percent frequency and cover for each colony (or clonal unit) needs to be set and requires prior research. Therefore, we are not recommending reclassification of *H. flava* from endangered to threatened. The existing recovery plan for *H. flava* contains objective, measurable criteria that need to be updated when the recovery plan is revised.

III. RESULTS

A. Recommended Classification

__X__ No change is needed

B. New Recovery Priority Number: 8C

The change from a recovery priority number of 7C to 8C is recommended because phylogenetic and morphological data suggested that the genus is not monotypic, see the *Taxonomic classification or changes in nomenclature* section for details. The degree of threat to this species continues to be moderate, and the recovery potential remains high. The 'C' category still applies because the species is in conflict with construction or other development project(s), i.e., activities related to roadside widening and maintenance along SR 65.

IV. RECOMMENDATIONS FOR FUTURE ACTION

Immediate actions

1. Location of further populations is essential, as this may lead to the discovery of new genets. This action can include the use of species distribution modeling methods to initially determine potential sites, with subsequent validation or inspection of the sites for plants.

2. Finding/identifying compatible genotypes is recommended to increase the likelihood of sexual reproduction.

3. *In-situ* conservation is essential and should aim to protect all populations as the loss of any single population leads to a substantial reduction in the overall genetic diversity. Specifically, Forest Service compartment no. 80 is important to protect because it contains a group of plants with unique genotypes. Additionally, the roadside population is vital to protect and preserve because it is comprised of unique multi-clone assemblages and distinctive genotypes.

4. *Ex- situ* conservation: A bank of seeds and ramets sampled from all known populations should be permanently maintained in nurseries in botanical gardens or other institutions, identified according to the source plant. This material could be used for reintroduction.

5. Secure the privately-owned population from Bay County via land acquisition, conservation easement, or by implementing permanent conservation measures between the Service and the AgReserves, Inc.

6. Continue fostering conservation practices for utility and highway ROWs with the Forest Service, FDOT, and the Service.

7. Since recruitment from seed appeared rare (Kesler and Trusty 2012, unp. report), the following studies are recommended: breeding systems, seed germination and seedling recruitment; the viability of dry-stored seeds, the timing of germination, and whether a persistent seed bank is present.

8. Label the clones identified by the genetic study.

Other actions

9. Due to the extensive clonality exhibited by this species, the word 'colony' (a term used in the Recovery Plan) should be replaced with 'clone'.

10. Monitoring/censusing

Although a comprehensive census throughout the present distribution, including all the historical locations is needed, it is recommended to set up subplots and monitor both flowering and non-flowering individuals. Given the cryptic nature of this plant when it isn't flowering, the density of surrounding vegetation and the number of locations, monitoring is best recommended a year post-fire (J. Drake, 2016, pers. comm.). In addition:

- A repeatable method should be employed. If the target population is small (e.g., 200 m^2), it is recommended to walk the entire area and count each individual. If the target population covers a large area, then permanent marked transects should be established in key selected areas that reflect the larger area.

- Population census data [e.g., the total number of individuals (flowering and non-flowering plants), and whether seedling recruitment is occurring] will help predict extinction risks and the smallest size at which a population can exist without facing extinction (i.e., the minimum viable population size) by using computer simulations known as population viability analyses. Emphasis should be given to clones and individuals with unique profiles identified by von Wettberg et al. (2015 unpubl. data) genetic study.

11. The effect of fire on clonality (including winter vs. growing season prescribed fire, fire frequency, intensity, duration, and timing) should be further investigated and monitored.

12. The recovery plan should be updated to define objective measurable criteria and better address the five factors.

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Participant	**Affiliation**
Sean Blomquist	Service
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U.S. FISH AND WILDLIFE SERVICE

5-YEAR REVIEW of

***HARPEROCALLIS FLAVA* (HARPER'S BEAUTY)**

Current Classification: Endangered

Recommendation resulting from the 5-Year Review

__x__ No change is needed

Reclassification Priority Number: 8C

The review was completed by botanist Dr. Vivian Negrón-Ortiz, Panama City Field Office.

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve Cathy D. Phillips Date 23 Feb 2016

APPENDIX A

Summary of peer review for the 5-year review of

Harperocallis flava (Harper's beauty)

A. Peer Review Method

The document was peer-reviewed internally by Ms. Mary Mittiga and Dr. Sean Blomquist of the Panama City Field Office and externally by two outside reviewers. The outside peer reviewers were chosen based on their qualifications and knowledge of the species.

B. Peer Review: The below guidance was provided to the reviewers.

1. Review all materials provided by the Service.
2. Identify, review, and provide other relevant data that appears not to have been used by the Service.
3. Do not provide recommendations on the Endangered Species Act classification (e.g., endangered, threatened) of the species.
4. Provide written comments on:
   - Validity of any models, data, or analyses used or relied on in the review.
   - Adequacy of the data (e.g., are the data sufficient to support the biological conclusions reached). If data are inadequate, identify additional data or studies that are needed to adequately justify biological conclusions.
   - Oversights, omissions, and inconsistencies.
   - Reasonableness of judgments made from the scientific evidence.
   - Scientific uncertainties by ensuring that they are clearly identified and characterized, and those potential implications of uncertainties for the technical conclusions drawn are clear.
   - Strengths and limitation of the overall product.
5. All peer reviews and comments will be public documents, and portions may be incorporated verbatim into our final document with appropriate credit given to the author of the review.

C. Summary of Peer Review Comments/Report

Peer reviewers recommended clarification and provided editorial comments. Outside reviewers were concerned about the recommended fire interval (FRI) of 4-5 years proposed by Kesler and Trusty (2012 unpubl. report). During a FRI of 4-5 years, many of *H. flava* sites will actually only burn every 8 to 12 years because the sites will be too wet with high density of swamp titi and other understory saplings; this will prevent fire from reaching those areas. Best recommendation: a FRI of two years. The new EOs from 2015 were not included in the map, therefore FNAI provided the raw data to the Service. They clarify the number of extant EOs in the ANF, and suggested that a comprehensive census just isn't possible or realistic (see action 10).

D. Response to Peer Review

All peer reviewers' comments were incorporated into the document.