

Adiantum vivesii
(no common name)

**5-Year Review:
Summary and Evaluation**

**U.S. Fish and Wildlife Service
Southeast Region
Ecological Services
Boquerón, Puerto Rico**

5-YEAR REVIEW
***Adiantum vivesii* (No common name)**

I. GENERAL INFORMATION

A. Methodology used to complete the review:

This 5-year review was prepared by a Service biologist and summarizes new information that the Service has gathered in the species file since it was listed on June 9, 1993. We conducted a literature search on the species, and new information consists of a Master Degree thesis conducted by Sepúlveda-Orengo (2000) from the University of Puerto Rico, Mayaguez Campus. On September 12, 2005, the Service published a notice in the *Federal Register* (70 FR 53807) announcing the 5-year review of *Adiantum vivesii* (a plant) and requesting new information concerning the biology and status of the species. A 60-day comment period was opened. No information on *Adiantum vivesii* was received from the public.

The review was sent to four peer reviewers (see List of Reviewers) on May 23, 2006. Two reviewers responded. Both reviewers agreed with the results obtained by Sepúlveda-Orengo (2000) pointing to a hybrid origin of *Adiantum vivesii*. Copies of the letters are included in Attachment 1.

Please see Addendum I (page 16-17) for updated information on this plant that we have gained while conducting our new five-year review initiated in 2017 (82 FR 29916). Our new signature page is included on page 15. What precedes this new information (pp. 2-14) is the first five-year review announced in September 12, 2005 (70 FR 53807) and completed and signed in 2008.

B. Reviewers

Lead Region: Kelly Bibb, Southeast Region (404) 679-7132.

Lead Field Office: Marelisa Rivera, Caribbean Ecological Services Field Office, Boquerón, Puerto Rico. (787) 851-7297, extension 231.

C. Background

1. FR Notice citation announcing initiation of this review: September 12, 2005; 70 FR 53807.

2. Species Status: 2005, 2006, 2007 Recovery Data Call - Stable. We are not aware of any significant changes to locations where this species is found, population number since previous status report (2005), and amount and imminence of threats.

3. Recovery Achieved: 1 (0-25%) of species recovery objectives achieved.

4. Listing History

Original Listing

FR notice: 58 FR 32308

Date listed: June 9, 1993
Entity listed: Species
Classification: Endangered

5. Review History: The June 9, 1993 Final Rule (58 FR 32308) and the Puerto Rican Endangered Ferns Recovery Plan, approved and signed on January 17, 1995 (U.S. Fish and Wildlife Service 1994), are the most recent comprehensive analysis of the species status and are used as the referenced point documents for this 5-year review.

The recovery plan is a multi-species plan and included seven endemic fern species (*Adiantum vivesii*, *Elaphoglossum serpens*, *Polystichum calderonense*, *Tectaria estremerana*, *Thelypteris inabonensis*, *Thelypteris verecunda*, and *Thelypteris yaucoensis*). The plan reported a single locality for *Adiantum vivesii* with approximately 1000 individuals. The species was described as a gregarious colonial fern found in the limestone or karst region of northwestern Puerto Rico. The June 9, 1993 Final Rule was the document where the Service analyzed the best available biological and ecological information, including threats to the species, the Service had at that time. When *A. vivesii* was listed, the species was only known from the type locality with approximately 1000 plants.

Every year the Service reviews species status and incorporates the information in the Recovery Data Call. In the 2007 Recovery Data call, we established that the status of the species was stable because we were not aware of any significant changes to either locations where this species occurs, population number since previous status review (2005), and amount and imminence of threats.

6. Species' Recovery Priority Number at start of review (48 FR 43098): 5. At the time of listing, *Adiantum vivesii* was recognized as a species with high degree of threat. Only one population of approximately 1000 individuals was known in a privately-owned land. Recovery potential for the species was considered to be low

7. Recovery Plan or Outline:

Name of plan: Puerto Rican Endangered Ferns Recovery Plan.
Date issued: January 17, 1995

II. Review Analysis

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

1. Is the species under review listed as a DPS? No.

The Act defines species to include any distinct population segment of any species of vertebrate wildlife. This definition limits listings as distinct population segments (DPS) only to vertebrate species of fish and wildlife. Because the DPS policy is not applicable to this plant species, it is 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 established downlisting as the Recovery Objective. The plan established four downlisting criteria for all seven species. The plan did not establish delisting criteria, and does not provide a reason.

2. Adequacy of recovery criteria

a. Do the recovery criteria reflect the best available (most up-to-date) information on the biology of the species and its habitat? No. At the time the recovery plan was signed, *Adiantum vivesii* was considered a species and the recovery criteria intended to provide long-term sustainability to the species. Long-term sustainability requires adequate reproduction for replacement of losses due to natural mortality factors (including disease and stochastic events), sufficient genetic robustness to void inbreeding depression and allow adaptation, sufficient habitat for long term population maintenance, and elimination or control of threats. Based on new information (Sepúlveda-Orengo 2000), it appears that *Adiantum vivesii* is not a valid species, capable of sexual reproduction. It also appears that what was previously considered a population of 1000 individuals is actually a single plant. The plant uses the rhizome for its vegetative reproduction and the entire population seems to be connected by them. Results from biosystematic analysis concluded that *Adiantum vivesii* may be a sterile hybrid. Under this scenario, long-term sustainability is extremely limited.

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

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, please note which of the 5 listing factors are addressed by that criterion. If any of the 5-listing factors are not relevant to this species, please note that here.

The plan established four downlisting criteria for all seven species:

1. The known populations are placed under protective status.
2. An agreement between the Service and the DNER concerning the protection of the three species in Commonwealth forests has been developed and implemented.
3. An agreement between the Service and Cornell University concerning the protection of *Tectaria estremeirana* on the Arecibo Radio Telescope property has been prepared and implemented.

4. New populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas.

None of these criteria have been met.

C. Updated Information and Current Species Status

1. Biology and Habitat

a. Is there relevant new information regarding the species' abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g. age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends? Yes.

When the species was listed in 1993, it was known from only one population in a privately-owned limestone hill in Quebradillas, Puerto Rico. Proctor (1991) estimated 1,000 plants, or growing apices, at the locality. Sepúlveda-Orengo (2000) located and measured the extent of the population, finding an area of 21m x 10m (68.9 ft x 32.8 ft). Located in the vicinity of the site location other eight species of the genus *Adiantum* were found (*A. cristatum*, *A. fragile*, *A. latifolium*, *A. melanoleucum*, *A. pulverulentum*, *A. tenerum*, *A. tetraphyllum* and *A. wilsonii*). The fern *Adiantum tetraphyllum* is growing intermixed within the area occupied by *Adiantum vivesii*.

Sepúlveda-Orengo (2000) made seven or eight deep excavations at different points throughout the entire population of *Adiantum vivesii*, and found rhizome connections between the apparent individuals in most of them. The excavations made to the population of *Adiantum tetraphyllum* showed that each apparent plant was a single plant. She collected and planted two 10 cm rhizome segments of *Adiantum vivesii*, and they grew into healthy plants within about three months. Production of sporangia was observed throughout the year, but gametophytes were not seen. Sepúlveda-Orengo (2000) suggested that the *Adiantum vivesii* population probably consists of only one individual with rhizome proliferations.

b. Is there relevant new information regarding the species' genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.)? Yes.

Sepúlveda-Orengo (2000) conducted morphometric analysis of *Adiantum vivesii* and *Adiantum tetraphyllum* based on 21 vegetative characters and one spore character. She also conducted chromosome counts; light microscopy observations of fresh or dried pinnules, sori, and sporangia of *Adiantum vivesii* and *Adiantum tetraphyllum*; and scanning electron microscopy (SEM) studies on rhizomes, fertile pinnules and spores.

In the morphometric analysis she found significant differences between *Adiantum vivesii* and *Adiantum tetraphyllum* for 16 of the vegetative characters as well as spore size, concluding that *Adiantum vivesii* appears to be a distinct morphological taxon. Based on

the results, the best morphological features that can be used in the field to distinguish *Adiantum vivesii* from *Adiantum tetraphyllum* are the number of lateral pinnae and the number of pinnules on each lateral pinna, which are fewer in *Adiantum vivesii*.

Sepúlveda-Orengo (2000) did not obtain preparations of sporogenous tissue from *Adiantum vivesii* to determine chromosome number. However, different stages of sporogenesis in the spore mother cells were found and photographically documented for the species. Although similar preparations of *Adiantum tetraphyllum* were not photographed, she concluded that it appeared that the two species had similar chromosome number, and that in any case *Adiantum vivesii* does not have twice the chromosome number of *Adiantum tetraphyllum*. She concluded that *Adiantum vivesii* does not appear to be a polyploid, at least of *Adiantum tetraphyllum*. Throughout the year sporangia and spores were produced, but signs of sexual reproduction as gametophytes or small plants were not observed. Sepúlveda-Orengo (2000) concluded that *Adiantum vivesii* does not appear to be a valid species, capable of sexual reproduction. The plant uses the rhizome for its vegetative reproduction and the entire population seems to be connected by them.

Based on the observations in the light microscopy and SEM studies, *Adiantum vivesii* appears to be sterile and may be a hybrid (Sepúlveda-Orengo 2000). One of its parent species may be *Adiantum tetraphyllum*, and the other is unknown. The author observed that the greater variation in spore size in *Adiantum vivesii* was mainly produced by spore abortion. Based Sepúlveda-Orengo (2000) sori (spores) containing abortive sporangia and spores may be an indicator of a hybrid. She found that the forms of the spores of *Adiantum vivesii* are quite different from *Adiantum tetraphyllum* because of the collapse of the exospore associated with the absence of the protoplast. The empty spores were commonly filled with air producing optically black areas within the exospore. Sepúlveda-Orengo (2000) reported that the mature sori of *Adiantum vivesii* seemed to be more compactly constructed than those of *Adiantum tetraphyllum*, with the sporangia appearing as more or less globular objects tightly grouped together. She concluded that this is consistent with the sorus of a hybrid. Based on the best available information which includes Sepúlveda-Orengo (2000), we believe *A. vivesii* is a sterile hybrid and no longer meets the definition of a species.

c. Is there relevant new information regarding taxonomic classification or changes in nomenclature? No.

d. Is there relevant new information regarding the species' 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.)? No.

e. Is there relevant new information addressing habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem)? No.

f. Is there any other relevant information on species? No.

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

(a) Present or threatened destruction, modification, or curtailment of its habitat or range;

When the species was listed in 1993, the Service identified habitat destruction and modification as one of the most significant factors affecting the species. The fact that the only known population occurred in a privately-owned land was a concern for the Service. Based on information discussed by Sepúlveda-Orengo (2000) accessibility to the site is controlled by the owner, the population is difficult to locate and identify, and the site is extremely difficult to access because it is a cliff. She determined that there is essentially no human impact in the area. Additionally, Sepúlveda-Orengo (2000) mentioned the willingness of the owner to protect the population.

(b) Overutilization for commercial, recreational, scientific or educational purposes;

In the final rule, this was not a factor in the decline of the species. At present time, we are not aware that overutilization for commercial, recreational, scientific or educational purposes constitutes a limiting factor for the species.

(c) Disease or predation;

In the final rule, this was not a factor in the decline of the species. At present time, we are not aware that disease or predation constitutes a limiting factor for the species.

(d) Inadequacy of existing regulatory mechanisms; and

In the final rule, the inadequacy of existing regulatory mechanisms to protect the species was identified as a threat. In 1999, the Commonwealth of Puerto Rico approved the Law # 241 known as the “Nueva Ley de Vida Silvestre de Puerto Rico”(New Wildlife Law of Puerto Rico). The purpose of this law is to protect, conserve and enhance both native and migratory wildlife species; declare property of Puerto Rico all wildlife species within its jurisdiction, regulate permits, regulate hunting activities, and regulate exotic species among others. The Puerto Rico Department of Natural and Environmental Resources approved in 2004 the “Reglamento para Regir el Manejo de las Especies Vulnerables y en Peligro de Extinción en el Estado Libre Asociado de Puerto Rico” (Regulation 6766 to regulate the management of threatened and endangered species in Puerto Rico). *Adiantum vivesii* has been included in the list of protected species and designated as “critically endangered”. This regulation under Article 2.06 prohibits collecting, cutting, removing, among other activities, listed plant individuals within the jurisdiction of Puerto Rico.

Based on the presence of Federal and Commonwealth laws and regulations protecting this species, we believe that inadequacy of existing regulatory mechanisms should no longer be considered a threat.

(e) Other natural or manmade factors affecting its continued existence.

Limited distribution of the species was also identified as an important factor affecting the species. When the species was listed the best available information showed a single colony of an estimated 1,000 plants. New information on the species reveals that it might be a single individual of a sterile hybrid. Under this scenario, limited distribution as a limiting factor may not apply. If *Adiantum vivesii* is a hybrid of *Adiantum tetraphyllum* and other unknown parent, the taxon might be more common than we previously thought. Proctor (1989) identified *Adiantum tetraphyllum* as of wide occurrence in suitable habitats. None of the other species of *Adiantum* reported from the site are either endemic to Puerto Rico, rare or restricted in distribution.

3. Synthesis

Adiantum vivesii was discovered by Proctor on August 31, 1985 in a privately-owned farm in Quebradillas, Puerto Rico. Proctor (1989, 1991) completed a status report for the species and reported about 1000 plants in one location. Sepúlveda-Orengo (2000) provided updated information suggesting that: 1) *Adiantum vivesii* is restricted to its type locality in Quebradillas; 2) the population probably consists only of one individual with rhizome proliferations; 3) it appears to be a distinct morphological taxon; 4) it does not appear to be a valid species, capable of sexual reproduction; 5) it does not appear to be a polyploidy, at least of *Adiantum tetraphyllum*; and 6) appears to be a sterile hybrid. The reviewers of the 5-year review agreed with the results obtained by Sepúlveda-Orengo (2000) pointing to a hybrid origin of *Adiantum vivesii*.

When the species was listed in 1993, the Service identified habitat destruction and modification as one of the most significant factors affecting the species. The fact that the only known population occurred in a privately-owned land was a concern for the Service. Updated information reveals that the degree of threat identified by the Service when the species was listed has been reduced, eliminated or does not apply any longer. Information provided by Sepúlveda-Orengo (2000) indicates that the accessibility to the location site is difficult because it is a cliff, the access of people to the site is limited, the population is difficult to be identified without a taxonomic guide, and essentially no human impact in the area have been observed. Sepúlveda-Orengo (2000) mentioned the willingness of the owner to protect the population. Under this scenario, the imminence of this factor is low.

Additionally, approved Law # 241 and Regulation 6766 protect the plant within the jurisdiction of Puerto Rico and none of the other species of *Adiantum* reported from the site is endemic to Puerto Rico, rare or restricted in distribution. Based on the best available information which includes Sepúlveda-Orengo (2000), we believe *A. vivesii* is a sterile hybrid and no longer meets the definition of a species. A species can be distinguished as a group of individuals that can potentially breed among themselves and

do not breed with individuals of other groups (Primack 2000). At present time, we have not identified overutilization, disease and predation as limiting factors for the species. Therefore, we believe *A. vivesii* should be delisted under the ESA.

III. RESULTS

A. Recommended Classification:

☐ Yes, downlisting to Threatened.
☐ Yes, uplisting to Endangered.
☒ Yes, delist.
☐ No, no change is needed.

Based on results from Sepúlveda-Orengo (2000) the fern *Adiantum vivesii* does not appear to be a good biological species, capable of sexual reproduction and appears to be a sterile hybrid.

B. New Recovery Priority Number: N/A

C. If applicable, indicate the Listing and Reclassification Priority Number:

Delisting (Removal from list regardless of current classification) Priority Number: 6.

We have determined that the delisting priority is low because it would have low management impact and it has not been petitioned.

IV. REFERENCES

Peer reviewed original research based on data

Proctor, G.R. 1989. Ferns of Puerto Rico and the Virgin Islands. The New York Botanical Garden, Bronx, New York. 389 pp.

Peer reviewed secondary research derived

Primack, R.B. 2000. A Primer of Conservation Biology, Second Edition. Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts, USA. 319pp.

Grey research based on data

Proctor, G.R. 1991. Puerto Rican Plant Species of Special Concern: Status and Recommendations. Publicación Científica Miscelánea No. 2. Departamento de Recursos Naturales. San Juan, Puerto Rico. 196pp.

Sepúlveda-Orengo, M.T. 2000. Biosystematic Analysis of *Adiantum vivesii* Proctor (Polypodiaceae: Adiantoideae), a Rare Fern Endemic to Northwestern Puerto Rico. A

thesis submitted in partial fulfillment of the requirements for the degree of Master in Science in Biology. University of Puerto Rico, Mayaguez Campus, Mayaguez, Puerto Rico. 80pp.

Grey literature based on literature analysis

U.S. Fish and Wildlife Service. 1993. Endangered and threatened wildlife and plants; determination of endangered status for four endemic Puerto Rican ferns. Federal Register Vo. 58 (109): 32308-32311.

U.S. Fish and Wildlife Service. 1994. Puerto Rico Endangered Ferns Recovery Plan. U.S. Fish and Wildlife Service, Atlanta, Georgia, 23pp.

List of Peer Reviewers

Dr. Duane Kolterman
Department of Biology
University of Puerto Rico, Mayaguez Campus
P.O. Box 9012
Mayaguez, Puerto Rico 00681
Phone: 787-332-4040, ext. 2269
E-mail: dkolterman@uprm.edu

Dr. Eugenio Santiago
Department of Biology
University of Puerto Rico, Rio Piedras Campus
Box 23360
San Juan, Puerto Rico 00931-3360
Phone: 787-764-0000, ext. 2905
E-mail: goetzea@yahoo.com

Dr. Pedro Acevedo Rodríguez
Department of Botany, MRC-166
Smithsonian Institution
P.O. Box 37012
Washington, DC 20013-7012
Phone: 202-633-0963
E-mail: acevedop@si.edu

Dr. Miguel A. García
Department of Natural and Environmental Resources
P.O. Box 9066600
San Juan, Puerto Rico 00940
Phone: 787-724-8774, ext. 4038, 4039
E-mail: miguelag@umich.edu

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Adiantum vivesii*

Current Classification Endangered

Recommendation resulting from the 5-Year Review

☐ **Downlist to Threatened**
☐ **Uplist to Endangered**
☒ **Delist**
☐ **No change is needed**

Appropriate Listing/Reclassification Priority Number 6

Review Conducted By Marelisa Rivera

FIELD OFFICE APPROVAL:

Edwin E. Muñoz, Lead Field Supervisor, U.S. Fish and Wildlife Service

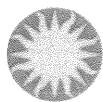
Approve _____ Date _____

REGIONAL OFFICE APPROVAL:

Sam D. Hamilton, Lead Regional Director, Fish and Wildlife Service

Approve _____ Date _____

Appendix 1. Letters of reviewers



Smithsonian
National Museum of Natural History

26 July 2006

Marelisa Rivera
Fish and Wildlife Biologist
Caribbean Field Office
P.O. Box 491
Boquerón, Puerto Rico 00622

Ref. Five year status review of *Adiantum vivesii*, Southeast Region's Ecological Services, Boquerón, Puerto Rico, May, 2006.

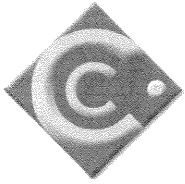
Dear Ms. Rivera:

Upon reviewing the 5 year review report on the status of the fern *Adiantum vivesii*, I concur with the analysis and recommendations made by Kelly Bibb of the Southeast Region. The current status of the referred fern as "endangered" should be maintained because some of the criteria that would guarantee the survival of this biological entity have not been met.

Although *Adiantum vivesii* is suspected to be a sterile hybrid, and therefore not a good biological species, regulatory mechanisms protecting this biological entity should be enforced. Speciation through hybridization is a common phenomenon in ferns, thus, the occurrence of sterile hybrid populations should be viewed as a stage in the speciation process. Therefore, the protection of incipient species such as *Adiantum vivesii*, has paramount importance in the protection of this important biological process and ultimately of new, rare species.

Sincerely,

Pedro Acevedo, Ph.D.
Research Scientist and Curator
Department of Botany
MRC-166, P.O. Box 37012
Washington, DC 20013-7012



**Center for Applied Tropical Ecology and Conservation
(CREST-CATEC)**

College of Natural Sciences
University of Puerto Rico
Río Piedras Campus
PO Box 23360
San Juan, Puerto Rico 00931-3360



August 14th, 2006

Marelisa Rivera
Fish and Wildlife Biologist
Caribbean Field Office
P.O. Box 491
Boquerón, Puerto Rico 00622

Dear Ms. Rivera.

This is in response to your request on commentaries on the endangered fern *Adiantum vivesii*, as part of the 5-year review of the species, conducted by the U.S. Fish and Wildlife Service.

The only study available is that by Sepulveda-Orengo (2000), which is being incorporated as part of the 5-year review for the species. This study provides strong evidence pointing to a hybrid origin of *A. vivesii*. Although it can be considered a distinct morphological taxon, this hybrid is not capable of sexual reproduction and thus, does not appear to be a good biological species. On the basis of this study, and given the large number of other "good taxa" that deserve priority of protection, I recommend that the Service consider de-listing *Adiantum vivesii*.

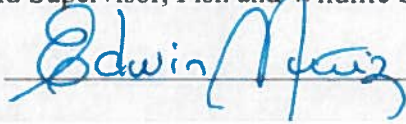
Sincerely,

Eugenio Santiago Valentín, Ph. D.
Associate Professor
Biology Department
Curator, UPR Botanical Garden Herbarium

FY 2018 APP ROVAL*

Lead Field Supervisor, Fish and Wildlife Service

Approve



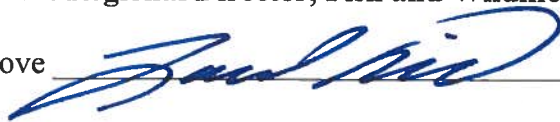
Date

8/22/2018

FY 2018 APPROVAL*

Assistant Regional Director, Fish and Wildlife Service

Approve



Date

9/25/18

Assistant Regional Director signature on this document reflects:

1. ☐ We have no new information, received no new public comments, and the original five factor analysis remains an accurate reflection of the species current status.
2. ☒ We have obtained a small amount of new information for *Adiantum vivensei* that we have summarized in Addendum 1, received no new public comments, and the original five factor analysis remains an accurate reflection of the species current status. We reaffirm the original delisting recommendation.

Addendum I

Summary of new information obtained since the 2008 *Adiantum vivesii* 5-Year Status Review

On June 30, 2017, the U.S. Fish and Wildlife Service (Service) published a notice in the Federal Register (82 FR 29916) announcing the five-year status review of *Adiantum vivesii* (no common name). It requested new information and comments from species experts and biologists familiar with this endangered fern concerning its biology and status. No comments were received from the public.

This addendum presents information the Service has obtained for the fern since the last *Adiantum vivesii* 5-year status review approved on June 5, 2008.

Updated information

The Fairchild Tropical Botanic Garden (Fairchild) has been collaborating with the Service on the assessment of natural populations, spore banking and the development of propagation protocols of the endangered ferns of Puerto Rico (Possley and Lange, 2016). In 2016, Fairchild engaged Dr. Emily Sessa from the University of Florida (UF) to assist on a genetic study to validate if *A. vivesii* is in fact a hybrid as indicated by Sepúlveda-Orengo (2000). In 2017 we conducted field work in collaboration with Fairchild to assess the population of *A. vivesii* and collected material for the genetic analyses.

Preliminary information from UF suggests there is high hybridization on the material collected for analysis (E. Sessa, Assistant Professor, UF, pers. comm. 2018). Dr. Sessa indicated that the samples labeled as *A. vivesii* have multiple alleles and do not appear to be closely related to one another. One seems likely related to (or actually is) *Adiantum pyramidale*, while the other one is close to *Adiantum tetraphyllum* and several unknown species.

Currently UF is working on getting further samples from the type specimens of *A. vivesii* stored at San Juan Herbarium (Puerto Rico Department of Natural and Environmental Resources) and National Herbarium (Smithsonian Institution) to extract DNA and validate their preliminary findings (E. Sessa, Assistant Professor, UF, pers. comm. 2018). This analysis will hopefully provide certainty on the hybrid status of the species and allow the Service to clarify the taxonomic status of *A. vivesii*.

Synthesis

The limited new information presented in this addendum support the information presented on the 2008-*Adiantum vivesii* 5 year status review, indicating *this* species is a hybrid. Therefore, we continue to believe *A. vivesii* should be delisted from the ESA (see Section III-Results).

There has not been any change in the threat analysis of the species (see Factor Analysis section).

Literature cited

- Possley, J. and J. Lange. 2017. Interim Report: Update on conservation efforts for federally endangered ferns of Puerto Rico's Cordillera Central. Report from Fairchild Tropical Botanic Garden to USFWS Caribbean Field office and Puerto Rico Departamento de Recursos Naturales y Ambiente, under Cooperative Agreement F14AC01201, Amendment No. 1. 24pp
- Possley, J and J. Lange. 2016. Conservation efforts for federally endangered ferns of Puerto Rico's Cordillera Central: 2014-2016 Summary. Report from Fairchild Tropical Botanic Garden to USFWS Caribbean Field office and Puerto Rico Departamento de Recursos Naturales y Ambiente. 15pp
- Sepúlveda-Orengo, M.T. 2000. Biosystematic Analysis of *Adiantum vivesii* Proctor (Polypodiaceae: Adiantoidae), a Rare Fern Endemic to Northwestern Puerto Rico. A thesis submitted in partial fulfillment of the requirements for the degree of Master in Science in Biology. University of Puerto Rico, Mayaguez Campus, Mayaguez, Puerto Rico. 80pp.
- Sessa, E. 2018. University of Florida. Personal communication. Email. June 27, 2018.