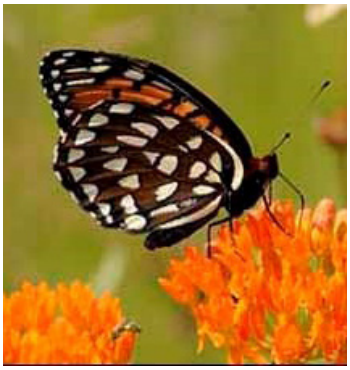
USDA United States Department of Agriculture
Natural Resources Conservation Service

Regal Fritillary *(Speyeria Idalia)*

Field Guide

The regal fritillary (Speyeria idalia) is a brush-footed butterfly with large, orange and black wings. Historically, it was found from Maine to Montana and south to Oklahoma and North Carolina. Habitat alteration, including loss of specific food plants and places to live/grow during critical stages of its life cycle has, over the past 30 years, reduced the species' range and abundance. Regal fritillary now occurs only in local colonies of remnant prairie in Pennsylvania and Virginia in the east, from southern Wisconsin west to Montana, and south to northeast Oklahoma in the west.



This species is considered critically imperiled in Pennsylvania (PNHP 2007) with just one known population at Fort Indiantown Gap (FTIG), Lebanon County. The U.S. Fish and Wildlife Service (USFWS) was petitioned in 2013 to list this species under the Endangered Species Act (ESA) of 1973, as amended. After a preliminary review of the petition, the USFWS announced in 2015 that listing may be warranted and is currently preparing the Species Status Assessment, which will be the underlying science document for the ESA listing determination scheduled for fiscal year 2022.

LIFE HISTORY

Regal fritillary butterflies have four life history stages: eggs, six larval instars, pupae, and adults. Male adults emerge in late spring with females appearing in early summer (NatureServe 2019). Adults mate in the mid to late summer, yet the female does not lay the eggs until fall. The extended period of time between mating and egg laying is known as "reproductive diapause" and is rare in other North American Lepidoptera (Kopper et al. 2001). This behavior appears to be an adaptation to the lifecycle of the larval food source—violets. The reproductive diapause during the heat of the summer and the overwintering of larvae allow the larvae to emerge in the spring when violet hostplants are young (Kopper et al. 2001).

Female regal fritillary butterflies may lay more than 2,000 eggs, singly, throughout their habitat (Ferster and Vulinec 2009). Eggs are laid on vegetation, dead leaves, and pebbles, but seldom on violets (NatureServe 2019). The eggs hatch in about 3 to 4 weeks (NatureServe 2019).

Larvae seek a hibernation site quickly after hatching. Based on observations of captive larvae, it appears larvae prefer to enter clumps of dried grass stems on the ground (NatureServe 2019). Once the larvae burrow into the litter, they enter diapause immediately and overwinter without feeding on host plants (NatureServe 2019). However, first instar larvae have been observed feeding on a portion or all of their chorion (eggshell; Wagner et al. 1997). After becoming active in the spring, they eat the leaves of young violets (Selby 2007).

Mortality for the regal fritillary is particularly high during the larval stage (Selby 2007). The larvae must survive winter and then locate a violet hostplant in spring, which it cannot detect from a distance of more than 1 to 2 cm. Larvae are also susceptible to disease, parasites, and direct and indirect mortality from fires that burn the vegetation where they are sheltered (Selby 2007). Following the pupal stage of 2 to 4 weeks, the adults emerge (Selby 2007).

In addition, evidence suggests the regal fritillary population at FTIG may be distinct genetically from the western population (Keyghobadi et al. 2012), further highlighting the need for conservation efforts.

HABITAT

Regal fritillary butterflies live in tall-grass prairie and other open and sunny locations such as damp meadows, marshes, wet fields, and mountain pastures (Vaughan and Shepherd 2005; Selby 2007). These early successional stage habitats were maintained through periodic, natural disturbance regimes. Regal fritillary habitat has been identified as "large grassland areas with prairie remnants or lightly grazed pasture lands containing prairie vegetation where topography often includes hills and valleys" (WDNR 2012). Regal fritillary butterflies depend on three main habitat components: violet hostplants for larvae, nectar plants for adults, and native warm-season bunch grasses that provide protective sites for all life stages (Swartz et al. 2015). Adults are encountered in both upland prairies and wet prairies, although larval development may be restricted to upland prairie where violet species grow (MDNR 2012). Wet prairies provide critical nectar sources under drought conditions.

Adults are rarely encountered away from native prairies and they appear to have a strong tendency to remain within the boundaries of these habitats. A viable (i.e., self-sustaining) population needs about 120 to 240 acres (NatureServe 2019). However, adults are frequently observed in remnant habitats that may be too small to support a self-sustaining population, suggesting that dispersal among remnants is common (Selby 2007) and that the butterflies will use somewhat degraded prairie habitats (NatureServe 2019). These butterflies are strong flyers and occasionally disperse over tens of kilometers. However, they tend to remain in the bounds of their natal prairie, especially if it is surrounded by trees, croplands, or roads (Powell et al. 2007).

LARVAL HOSTPLANTS

Violets are the sole larval hostplant for the regal fritillary, though the species of violets used varies (Vaughan and Shepherd 2005; NatureServe 2019; Selby 2007). Larvae use young or intermediately aged violet plants for food (Kopper et al. 2001) but also require warm-season grasses for cover (Ferster and Vulinec 2009). The butterfly might use any species of violet in its habitat, but they have been observed on the arrow-leaved violet (Viola sagittata; V. fimbriatula), birdfoot violet (V. pedata), prairie violet (V. pedatifida) and lance-leaved violet (V. lanceolata) (NatureServe 2019). Viable populations require a large number of violet plants.

ADULT NECTAR PLANTS

Adult regal fritillaries are nectarivores. Adults feed on nectar from various flowers such as milkweeds (Asclepias spp.), native thistles (Cirsium spp.), blazing stars (Liatris spp.), coneflowers (Echinacea spp.), joe-pye weeds (Eutrochium spp.), wild bergamot (Monarda Fistulosa, and ironweeds (Vernonia spp.) (NatureServe 2019). However, "no single nectar genus is crucial and nectar resources nearly always change over the season" (NatureServe 2019). If a reliable source of nectar is not available, adult regal fritillaries "will emigrate from an area quickly" (NatureServe 2019). This need appears to be driven by demanding nutritional requirements of an extended adult lifespan (Selby 2007). Nectar availability limitations may lead to decreased fecundity and fertility.

HABITAT RESTORATION RECOMMENDATIONS

Priority areas in Pennsylvania –

- The FTIG population in Lebanon County is the last remaining population in the eastern U.S.
- Priority area is around FTIG in Lebanon County (green shading in Figure 1) to enable the population to expand beyond FTIG.
- As population expands into habitat surrounding FTIG, target habitat expansion into surrounding counties (orange markers in Figure 1) that were historically occupied in eastern Pennsylvania.

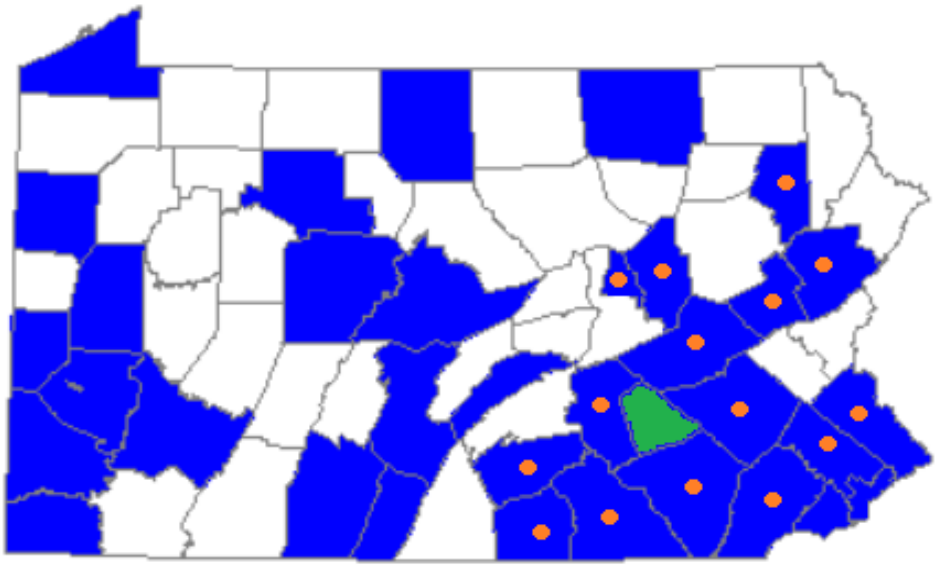


Figure 1. Historical (blue) distribution and priority area (green) of Regal Fritillary (Speyeria idalia) in Pennsylvania. Counties with orange markers are targeted expansion areas.

Habitat Sub-Types and Target Species

1) Diverse prairie interspersed with native violets (less than 20% bare ground)
   - Native warm season bunch grasses
     - 20-40% of plant cover (Swartz et al. 2015)
     - Little bluestem (Schizachyrium scoparium) 2 - throughout PA
     - Broomsedge (Andropogon virginicus) 2 - throughout PA
     - Other native warm-season grasses with similar structure
   - Adult nectar sources - critical for flowering to span late May to late September
     - Adult nectar sources greater than 60% cover; 600 plants/acre (derived from Swartz et al. 2015)
     - milkweeds (200 plants/acre; derived from Swartz et al. 2015)
       - common milkweed (Asclepias syriaca) 2 – throughout PA
       - orange/butterfly milkweed (A. tuberosa) 2 - all but northern tier
     - native thistles (200 plants/acre; derived from Swartz et al. 2015)
       - pasture thistle (Cirsium pumilum) 2 – throughout PA
       - field thistle (C. discolor) 2 – all but extreme Erie basin and west central
     - diverse preferred forbs (200 plants/acre; derived from Swartz et al. 2015), as listed in table on page 4.

COMMON NAME	SPECIES	RANGE IN PA
Dense Blazing Star	*Liatris spicata*	Southeast, Allegheny Watershed
Tall Gayfeather	*Liatris scariosa*	Appalachian Range
Purple Coneflower	*Echinacea purpurea*	Southeast
Sweet Joe-Pye Weed	*Eutrochium purpureum* *(formerly Eupatorium purpureum)*	Throughout
Giant Ironweed	*Vernonia gigantean*	Western
Indian Hemp	*Apocynum cannabinum*	Throughout
Hoary Mountainmint	*Pycnanthemum incanum*	All but Allegheny Watershed
Bigleaf Mountainmint	*Pycnanthemum muticum*	Southeast
Canada Goldenrod	*Solidago canadensis*	Throughout
White Goldenrod	*Solidago bicolor*	Throughout
Early Goldenrod[1]	*Solidago juncea*	Throughout
Gray Goldenrod[1]	*Solidago nemoralis*	Throughout
Sweet Goldenrod	*Solidago odora*	Eastern
Downy Goldenrod[1]	*Solidago puberula*	Eastern
Calico Aster	*Symphyotrichum lateriflorum*	Throughout
New Englander Aster	*Symphyotrichum novae-angliae*	Throughout
Heath Aster	*Symphyotrichum pilosum*	Throughout

[1] denotes dominant plant in occupied habitat at FTIG.

- Larval host plants – limiting factor for egg-laying and larval feeding
  - violets that thrive in dry, grassy areas (at least 6,000 violets/acre)
    - arrowleaf violet (V. sagittata; V. fimbriatula) 2 - throughout PA
    - birdfoot violet (Viola pedata) – south central to south east PA
    - lance-leaved violet (V. lanceolata) – all but northern tier of PA

2) Wet meadows and swales

- Native warm season bunch grasses
  - 30 to 40% of plant cover
  - Broomsedge (Andropogon virginicus)
  - Deertongue (Dichanthelium clandestinum; formerly Panicum clandestinum)
  - Other native wet meadow grasses with similar structure

- Adult nectar sources - critical for flowering to span late May to late September
  - 60% cover in spring prior to grass growth
  - milkweeds (75 plants/acre)
    - swamp milkweed (A. incarnata) – throughout
  - native thistles (75 plants/acre)

- swamp thistle (C. muticum) - throughout
- high diversity of other preferred forbs (150 plants/acre)

COMMON NAME	SPECIES	RANGE IN PA
Grass-Leaved Goldenrod[1]	*Euthamia graminifolia*	Throughout
Spotted Joe-Pye Weed	*Eutrochium maculatum*	Northern Tier, Southest, Southwest
Joe-Pye Weed	*Eutrochium fistulosum*	Throughout
New York Ironweed	*Vernonia noveboracensis*	All but North Central and Northeast
Scarlet Beebalm	*Monarda didyma*	All but Appalachian Ridge Top
Purple Bergamot	*Monarda media*	Southwest, Eastern Border
Narrowleaf Mountainmint	*Pycnanthemum tenuifolium*	Throughout
Virginia Mountainmint	*Pycnanthemum virginianum*	All but Northern Tier
Roundleaf Goldenrod	*Solidago patula*	West and Southeast
Wrinkleleaf Goldenrod[1]	*Solidago rugosa*	Throughout
Bog Goldenrod	*Solidago uliginosa*	Northeast and Northwest
New England Aster	*Symphyotrichum novae-angliae*	Throughout
Purplestem Aster	*Symphyotrichum puniceum*	Throughout
Crookenstem Aster	*Symphyotrichum prenanthoides*	Throughout
Late Purple Aster	*Symphyotrichum patens*	All but Erie Basin and Allegheny Watershed

[1] denotes dominant plant in occupied habitat at FTIG.

Restoration Approaches

Objective – create prairie upland habitat with violets interspersed with wet meadow patches or swales using the target species identified above under a diverse disturbance regime (see Long-Term Maintenance section).

1) Crop Field Conversion
   - Herbicide – One application of a non-persistent herbicide to control weeds
   - Prairie and Wet Meadow seed mixes - fall with cover crop or spring without
   - Violet seeds (fall or spring in mix) or plugs (spring only)

2) Hayfield/Pasture Conversion (with interim crop)
   - Herbicide – Fall and Spring applications of a non-persistent herbicide to eliminate grasses and weeds
   - Crops – Soybeans followed by winter cover crop or seed mix with cover crop
   - Prairie and Wet Meadow seed mixes – fall with cover crop or spring without
   - Violet seeds (fall or spring in mix) or plugs (spring only)

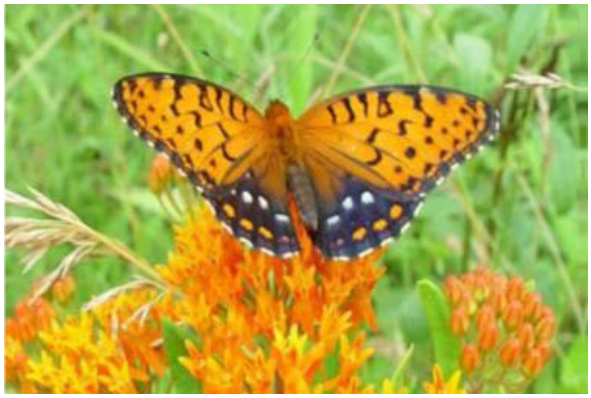
3) Warm season grass areas or swales lacking preferred forbs (spring only)
   - Mowing
   - Nectar plant plugs
   - Violet plugs

LONG-TERM MAINTENANCE

Because the required larval food and adult nectar needs along with resting sites persist only with recurring disturbance, a practical, biologically effective, and essentially permanent program of disturbance is required to sustain populations (Latham et al. 2007).

1) Existing Habitat
   - The species' presence must be documented. Local naturalists should be queried to document their observations. Surveys should be conducted using the methods and schedule from FTIG (Ferster and Vulinec 2009). As misidentification is unlikely, vouchers are not necessary for this species. Photo documentation is warranted.
   - If present, evaluate the existing disturbance regime (e.g., burning, mowing, cattle grazing (little damage to violets), vehicular traffic). For populations less than 100 adults, existing disturbance activities should be evaluated and potentially revised (NatureServe 2019). Where an existing population has been maintained without fire, do not introduce fire (NatureServe 2019). If mowing is used, thatch must be removed to prevent smothering of violets.
   - Disturbances should be used on small proportions (no more than one-quarter) of the occupied habitat in any one year and in scattered patches to create a mosaic of post-disturbance successional stage habitats. Management activities should be during the dormant season to avoid destroying eggs or larvae. Intervals must be set to accommodate the critical plant species in each area: grass and nectar areas should be on a 3 - 4 year cycle in uplands, while wet meadows may need disturbances every 2 - 3 years to limit woody species (Latham et al. 2007). Violets need disturbances every 2 to 3 years to prevent shading (Latham et al. 2007). Vehicle tracking, mowing, and light grazing are more conductive to maintaining mosaics on divergent schedules than burning. Unlike burning, they can be used to improve violet areas without severely reducing grass and nectar plant cover when only adults are present.
   - If adjacent to crops, implement an adequate buffer to prevent effects from pesticide drift, including biocides.

2) Restored Habitat
   - Conduct surveys and/or use citizen scientists to monitor butterfly occupancy.
   - Use vehicle tracking, mowing, and light cattle grazing to maintain mosaics on divergent schedules. Avoid using sheep or goats as effects of these grazers on violets is unknown. If mowing is used, thatch must be removed to prevent smothering of violets.
   - Perform activities during the dormant season when larvae are overwintering in the organic layer.
   - Maintain violet areas without severely reducing grass and nectar plant cover.
   - Maintain an adequate buffer to prevent effects from pesticide drift, including biocides.



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