

## Appendices for Draft Central Texas General Conservation Plan

Appendix A. ....	2
Table A.1. ....	2
Table A.2. ....	10
Table A.3. ....	22
Table A.4. ....	24
Figure A.1. ....	38
Figure A.2. ....	39
Figure A.3. ....	40
Figure A.4. ....	41
Figure A.5. ....	42
Figure A.6. ....	43
Figure A.7. ....	44
Figure A.8. ....	45
Appendix B. ....	46
Appendix C. ....	48
Appendix D. ....	51
Appendix E. ....	54
Appendix F. ....	55
Appendix G. ....	57
Appendix H. ....	87

## Appendix A.

Information (as of February 2013) about species of concern not covered by the CTGCP, including the following:

Table A.1. Federally listed and candidate species in CTGCP Permit Area (p. 2)

Table A.2. Additional state-listed species and species under review for federal listing or recently petitioned in CTGCP Permit Area (p. 4)

Table A.3. Additional federally-listed species and species of concern that occur in CTGCP Plan Area but outside the Permit Area or that do not realistically occur in CTGCP Plan Area (although they're listed in some state and federal websites). (p. 10)

Table A.4. Listed species or species of concern (from Tables 1 and 2) listed by county (p. 12)

Figures A.1– A.8. Range maps for species listed in Tables 1 and 2. (p. 26)

### Table A.1.

Federally listed and candidate species (state status not noted) occurring in the CTGCP Permt Area. Status abbreviations: E = Endangered, T = Threatened

Species	Taxon, Fed. status	Texas distribution	County-level overlap with CTGCP Plan Area	Habitat (relative to CTGCP)	Threats	Range map Figure #; data source
<b>FEDERAL THREATENED AND ENDANGERED SPECIES</b>						
Clear Creek gambusia, <i>Gambusia heterochir</i>	Fish, E	exists only in spring-fed headwaters of Clear Creek (trib to San Saba) in Menard Cty	Menard	clear, slightly acidic spring water of constant temperature, with abundant aquatic vegetation	limited distribution; dams; hybridization and competition; dependent on water flow and quality from Wilkinson Springs	A.1; FWS 5-year review (2010)
Devils River minnow, <i>Dionda diaboli</i>	Fish, T	known from 1 creek in Kinney Cty, and 2 creeks in Val Verde Cty	Kinney	flowing spring-fed waters; found over gravel-cobble substrate, usually associated with aquatic macrophytes	reduction in spring flows; reduction in water quality; predation and competition with nonnative species	A.1; FWS 5-year review (2008)
Interior least tern, <i>Sterna antillarum athalassos</i>	Bird, E	breeds in isolated areas along the Red and Rio Grande river systems; also Trinity River drainage from Dallas scattered downstream; migrates to Texas coast for winter	Dallas	nests on open sandy beaches, sandbars, unvegetated islands, and deposited materials along the coasts of oceans, bays, inland rivers, large lakes and reservoirs	habitat loss due to dams, reservoirs, and other changes to river systems; nest disturbance	A.3; TOS
Piping plover, <i>Charadrius melodus</i>	Bird, T	migrates from Great Lakes to Gulf Coast	Dallas	migration = beaches and alkali flats; reservoir shorelines, natural lakes, rivers, marsh wetlands, industrial ponds and fish farms	development	A.3; TOS
Whooping crane, <i>Grus</i>	Bird, E	Texas population migrates from Canada to Texas coast	migration = Bell, Bexar, Blanco, Bosque, Burnet,	migration = feed in a variety of croplands and roosts in	degradation of habitat due in part to draining, fencing,	A.3; FWS 5-year review

<i>americana</i>			Comal, Coryell, Dallas, Eastland, Erath, Gillespie, Hamilton, Hays, Hill, Hood, Jack, Johnson, Kendall, Lampasas, Llano, Mason, McLennan, Palo Pinto, San Saba, Somervell, Stephens, Travis, Williamson, Young	palustrine (freshwater inland, shallow) wetlands	plowing related to ag uses; human disturbance	(2011)
Wood stork, <i>Mycteria americana</i>	Bird, E <sup>1</sup> (not in TX)	postbreeders from Mexico may occur in scattered areas of Texas	Bexar, Dallas, Hill, McLennan	almost all types of freshwater and saltwater wetlands, with prey species and suitable water depths	pesticides, degradation of habitat due to urban and ag expansion (altered hydrological patterns), human disturbance	A.3; TOS/TPWD
Texas snowbells, <i>Styrax platanifolius</i> ssp. <i>texanus</i>	Plant, E	known from 22 populations in 3 counties	Edwards, Kinney, Real	moist habitats such as river drainages, canyons, and draws in Edwards Plateau; associated w/juniper-oak woodlands	small population, lack of reproduction, possibly affected by deer and cattle browsing	A.4; FWS 5-year review (2008)
Tobusch fishhook cactus, <i>Sclerocactus brevihamatus</i> ssp. <i>tobuschii</i>	Plant, E	known from scattered locations in southwest Edwards Plateau	Bandera, Edwards, Kerr, Kimble, Kinney, Real, Uvalde	patches of shallow, moderately alkaline, rocky loams or clays over fractured limestone bedrock; open, full sunlight, thin herbaceous cover but within a matrix of woodland or savanna; surrounding community is primarily live oak-juniper woodlands	subdivision of large ranches, leading to increase in roads, fences, power lines, and residential development	A.4; FWS 5-year review (2010)
<b>FEDERAL CANDIDATE SPECIES</b>						
Golden orb, <i>Quadrula aurea</i>	Mussel	known from San Antonio, San Marcos, and lower Guadalupe Rivers	Bexar, Blanco, Comal, Hays, Kendall, Kerr, Medina	Not well known; sand and gravel in some locations and mud at others; found in lentic and lotic	impoundments, sedimentation (due to ag activities, instream sand and gravel mining, vegetation removal, and urbanization), dewatering, chemical contaminants	A.2; C. Randklev
Smooth pimpleback, <i>Quadrula houstonensis</i>	Mussel	known from parts of the Colorado and Brazos River basins	Bell, Blanco, Bosque, Burnet, Coryell, Eastland, Erath, Hamilton, Hill, Hood, Johnson, Kimble, Lampasas, Llano, Mason, McLennan, Menard, Palo Pinto, San Saba, Somervell, Stephens,	Not well known; mixed mud, sand, and fine gravel, tolerates very slow to moderate flow rates	impoundments, sedimentation (due to ag activities, instream sand and gravel mining, vegetation removal, and urbanization), dewatering, chemical contaminants	A.2; C. Randklev

			Travis, Williamson, Young			
Texas fatmucket, <i>Lampsilis bracteata</i>	Mussel	known from parts of the Colorado River basin	Bandera, Bexar, Blanco, Burnet, Comal, Gillespie, Hays, Kendall, Kerr, Kimble, Lampasas, Llano, Mason, Menard, San Saba, Travis	Not well known; streams and rivers on sand, mud, and gravel substrates; broken bedrock and coarse gravel or sand in moderately flowing water	impoundments, sedimentation (due to ag activities, instream sand and gravel mining, vegetation removal, and urbanization), dewatering, chemical contaminants	A.2; C. Randklev
Texas fawnsfoot, <i>Truncilla macrodon</i>	Mussel	known from parts of the Colorado and Brazos River basins	Bell, Blanco, Bosque, Burnet, Coryell, Hamilton, Hill, Hood, Johnson, Kimble, Lampasas, Llano, Mason, McLennan, Menard, Palo Pinto, San Saba, Somervell, Stephens, Travis, Williamson, Young	Not well known;; possibly rivers and larger streams; flowing rice irrigation canals, possibly sand, gravel, and perhaps sandy-mud bottoms in moderate flows	impoundments, sedimentation (due to ag activities, instream sand and gravel mining, vegetation removal, and urbanization), dewatering, chemical contaminants	A.2; C. Randklev
Texas pimpleback, <i>Quadrula petrina</i>	Mussel	known from Guadalupe and upper Colorado River basins	Bandera, Bexar, Blanco, Burnet, Comal, Gillespie, Hays, Kendall, Kerr, Kimble, Lampasas, Llano, Mason, Medina, Menard, San Saba, Travis	Not well known; mud, gravel and sand substrates, generally in areas with slow flow rates	impoundments, sedimentation (due to ag activities, instream sand and gravel mining, vegetation removal, and urbanization), dewatering, chemical contaminants	A.2; C. Randklev
Sharpnose Shiner, <i>Notropis oxyrhynchus</i>	Fish	Brazos River Basin; apparently stable in Upper Brazos, remnant or extirpated from Middle and Lower	Bosque, Hill, Hood, McLennan, Palo Pinto, Somervell, Young	mainstem river; occurs in fairly shallow water in broad, open, sandy channels with moderate current	present and continued modification of its habitat by reservoir construction, irrigation and water diversion, sedimentation, industrial and municipal discharges, and agricultural activities	A.1; FWS species assessment (2011) - simplified to Brazos River
Smalleye Shiner, <i>Notropis buccula</i>	Fish	Brazos River Basin, apparently extirpated from all but Upper Brazos	Young	mainstem river; occurs in fairly shallow water in broad, open, sandy channels with moderate current	present and continued modification of its habitat by reservoir construction, irrigation and water diversion, sedimentation, industrial and municipal discharges, and agricultural activities	A.1; FWS species assessment (2011) - simplified to Brazos River
Salado Salamander, <i>Eurycea chisholmensis</i>	Amphibian	known from 2 spring sites fed by Edwards Aquifer near Salado, Bell County	Bell, possibly Williamson	known only from the immediate vicinity of spring outflows, under rocks, and in gravel substrate	degradation of water quality and quantity due to urbanization	A.1; FWS species assessment (2010) and Fed. Reg. 8-



						22-12
Red Knot, <i>Calidris canutus ssp. rufa</i>	Bird	migrates through Texas/Louisiana along interior flyway	migration = possibly all	sandy beach, tidal mudflat, salt marsh	destruction and modification of its habitat, particularly the reduction in key food resources resulting from reductions in horseshoe crabs	A.3; TOS
Sprague's Pipit, <i>Anthus spragueii</i>	Bird	rare migrant and casual winter resident throughout most of Texas, winter primarily in central and southern coastal prairies	all	migration/winter = well-drained areas in open grassland, preferably native grass; grasslands with even low densities of shrubs are avoided	habitat loss and conversion, habitat fragmentation on the breeding grounds, energy development, roads	A.3; TOS/TPWD
Bracted twistflower, <i>Streptanthus bracteatus</i>	Plant	known from scattered locations in southeast Edwards Plateau	Bandera, Bexar, Comal, Hays, Medina, Real, Travis, Uvalde	mostly at or near ridgetops in thin clay soils overlying limestone formations; tree canopy cover ~25-100%; shrub understory often dense; little herbaceous ground cover; research suggests species is best adapted to sites with <50% woody plant cover	habitat destruction from urban development, severe herbivory from very dense herds of white-tailed deer, and the increased density of woody plant cover	A.4; FWS species assessment (2011)
<sup>1</sup> Proposed reclassification from Endangered to Threatened, 26 Dec 2012						

Data sources:

Website links for additional detail about species' habitat associations, threats, and conservation actions for species listed in Table A.1. Species are listed alphabetically by common name.

**Bracted twistflower, *Streptanthus bracteatus***

NatureServe Explorer: *Streptanthus bracteatus*

TPWD: Rare, Threatened, and Endangered Species of Texas, Bracted twistflower

University of Texas Native Plant Database: [http://www.wildflower.org/plants/result.php?id\\_plant=STBR](http://www.wildflower.org/plants/result.php?id_plant=STBR)

USDA Plants Profile: <http://plants.usda.gov/java/profile?symbol=STBR>

USFWS: Species Profile Page, Bracted twistflower (*Streptanthus bracteatus*)

USFWS, Species assessment and listing priority (2012): [http://ecos.fws.gov/docs/candidate/assessments/2013/r2/Q1R7\\_P01.pdf](http://ecos.fws.gov/docs/candidate/assessments/2013/r2/Q1R7_P01.pdf)

**Clear Creek gambusia, *Gambusia heterochir***

Campbell 2003: [http://www.tpwd.state.tx.us/publications/pwdpubs/media/pwd\\_bk\\_w7000\\_0013\\_clear\\_creek\\_gambusia.pdf](http://www.tpwd.state.tx.us/publications/pwdpubs/media/pwd_bk_w7000_0013_clear_creek_gambusia.pdf)

IUCN: <http://www.iucnredlist.org/details/8892/0>

NatureServe Explorer: *Gambusia heterochir*

Texas State University: <http://www.bio.txstate.edu/~tbonner/txfishes/gambusia%20heterochir.htm>

TPWD: Rare, Threatened, and Endangered Species of Texas, Clear Creek gambusia

TPWD, Wildlife Fact Sheets: <http://www.tpwd.state.tx.us/huntwild/wild/species/clearcreekgambusia/>

USFWS: Species Profile Page, Clear Creek gambusia (*Gambusia heterochir*)

USFWS, 5-year Review (2010): [http://ecos.fws.gov/docs/five\\_year\\_review/doc3232.pdf](http://ecos.fws.gov/docs/five_year_review/doc3232.pdf)

USFWS, Recovery Plan (1982): [http://ecos.fws.gov/docs/recovery\\_plan/820114.pdf](http://ecos.fws.gov/docs/recovery_plan/820114.pdf)

**Devils River minnow, *Dionda diaboli***

IUCN: <http://www.iucnredlist.org/details/6623/0>

NatureServe Explorer: *Dionda diaboli*

Texas State University: <http://www.bio.txstate.edu/~tbonner/txfishes/dionda%20diaboli.htm>

TPWD: Rare, Threatened, and Endangered Species of Texas, Devils River minnow

TPWD leaflet: [http://www.tpwd.state.tx.us/publications/pwdpubs/media/pwd\\_bk\\_w7000\\_0013\\_devils\\_river\\_minnow.pdf](http://www.tpwd.state.tx.us/publications/pwdpubs/media/pwd_bk_w7000_0013_devils_river_minnow.pdf)

USFWS: Species Profile Page, Devils River minnow (*Dionda diaboli*)

USFWS, 5-year Review (2008): [http://ecos.fws.gov/docs/five\\_year\\_review/doc1978.pdf](http://ecos.fws.gov/docs/five_year_review/doc1978.pdf)

USFWS, Recovery Plan (2005): [http://ecos.fws.gov/docs/recovery\\_plan/050913.pdf](http://ecos.fws.gov/docs/recovery_plan/050913.pdf)

USFWS, Designation of Critical Habitat for the Devils River Minnow: <http://www.gpo.gov/fdsys/pkg/FR-2008-08-12/pdf/E8-17985.pdf#page=1>

**Golden orb, *Quadrula aurea***

NatureServe Explorer: *Quadrula aurea*

TPWD: Rare, Threatened, and Endangered Species of Texas, Golden orb

TPWD, Listing as Threatened: [http://www.tpwd.state.tx.us/huntwild/wild/wildlife\\_diversity/texas\\_rare\\_species/mussels/media/state\\_mussels.pdf](http://www.tpwd.state.tx.us/huntwild/wild/wildlife_diversity/texas_rare_species/mussels/media/state_mussels.pdf)

USFWS: Species Profile Page, Golden orb (*Quadrula aurea*)

USFWS, Species assessment and listing priority (2012): [http://ecos.fws.gov/docs/candidate/assessments/2013/r2/F04J\\_I01.pdf](http://ecos.fws.gov/docs/candidate/assessments/2013/r2/F04J_I01.pdf)

**Interior least tern, *Sterna antillarum athalassos***

Campbell 2003: [http://www.tpwd.state.tx.us/publications/pwdpubs/media/pwd\\_bk\\_w7000\\_0013\\_interior\\_least\\_tern.pdf](http://www.tpwd.state.tx.us/publications/pwdpubs/media/pwd_bk_w7000_0013_interior_least_tern.pdf)

Cornell Lab of Ornithology: [http://www.allaboutbirds.org/guide/Least\\_Tern/id](http://www.allaboutbirds.org/guide/Least_Tern/id)

IUCN: <http://www.iucnredlist.org/details/106003278/0>

NatureServe Explorer: *Sterna antillarum athalassos*

TPWD: Rare, Threatened, and Endangered Species of Texas, Interior Least Tern

TPWD, Wildlife Fact Sheets: <http://www.tpwd.state.tx.us/huntwild/wild/species/leasttern/>

USFWS: Species Profile Page, Least tern (*Sterna antillarum*)

**Piping plover, *Charadrius melodus***

Campbell 2003: [http://www.tpwd.state.tx.us/publications/pwdpubs/media/pwd\\_bk\\_w7000\\_0013\\_piping\\_plover.pdf](http://www.tpwd.state.tx.us/publications/pwdpubs/media/pwd_bk_w7000_0013_piping_plover.pdf)

Cornell Lab of Ornithology: [http://www.allaboutbirds.org/guide/Piping\\_Plover/id](http://www.allaboutbirds.org/guide/Piping_Plover/id)

IUCN: <http://www.iucnredlist.org/details/106003127/0>

NatureServe Explorer: *Charadrius melodus*

TPWD: Rare, Threatened, and Endangered Species of Texas, Piping Plover

TPWD, Wildlife Fact Sheets: <http://www.tpwd.state.tx.us/huntwild/wild/species/piplover/>

USFWS: Species Profile Page, Piping Plover (*Charadrius melodus*)

USFWS, 5-year Review (2009): [http://ecos.fws.gov/docs/five\\_year\\_review/doc3009.pdf](http://ecos.fws.gov/docs/five_year_review/doc3009.pdf)

**Red Knot, *Calidris canutus ssp. rufa***

Cornell Lab of Ornithology: [http://www.allaboutbirds.org/guide/Red\\_Knot/id](http://www.allaboutbirds.org/guide/Red_Knot/id)

IUCN: <http://www.iucnredlist.org/details/106003041/0>

NatureServe Explorer: *Calidris canutus rufa*

USFWS: Species Profile Page, Red Knot (*Calidris canutus ssp. rufa*)

USFWS, Species assessment and listing priority (2011): [http://ecos.fws.gov/docs/candidate/assessments/2012/r5/B0DM\\_V01.pdf](http://ecos.fws.gov/docs/candidate/assessments/2012/r5/B0DM_V01.pdf)

**Salado Salamander, *Eurycea chisholmensis***

AmphibiaWeb: [http://amphibiaweb.org/cgi/amphib\\_query?where-genus=Eurycea&where-species=chisholmensis](http://amphibiaweb.org/cgi/amphib_query?where-genus=Eurycea&where-species=chisholmensis)

Herps of Texas: <http://www.herpssoftexas.org/content/salado-salamander>

IUCN: <http://www.iucnredlist.org/details/59263/0>

NatureServe Explorer: *Eurycea chisholmensis*

TPWD: Rare, Threatened, and Endangered Species of Texas, Salado Springs salamander

USFWS: Species Profile Page, Salado Salamander (*Eurycea chisholmensis*)

USFWS, Endangered Status for Four Central Texas Salamanders and Designation of Critical Habitat: <http://www.gpo.gov/fdsys/pkg/FR-2012-08-22/pdf/2012-19659.pdf>

USFWS, Species assessment and listing priority (2010): [http://ecos.fws.gov/docs/candidate/assessments/2010/r2/D02X\\_V01.pdf](http://ecos.fws.gov/docs/candidate/assessments/2010/r2/D02X_V01.pdf)

**Sharpnose Shiner, *Notropis oxyrhynchus***

IUCN: <http://www.iucnredlist.org/details/14892/0>

NatureServe Explorer: *Notropis oxyrhynchus*

Texas State University: <http://www.bio.txstate.edu/~tbonner/txfishes/notropis%20oxyrhynchus.htm>

TPWD: Rare, Threatened, and Endangered Species of Texas, Sharpnose shiner

USFWS: Species Profile Page, Sharpnose Shiner (*Notropis oxyrhynchus*)

USFWS, Species assessment and listing priority (2011): [http://ecos.fws.gov/docs/candidate/assessments/2012/r2/E04K\\_V01.pdf](http://ecos.fws.gov/docs/candidate/assessments/2012/r2/E04K_V01.pdf)

USGS: <http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=604>

**Smalleye Shiner, *Notropis buccula***

IUCN: <http://www.iucnredlist.org/details/14883/0>

NatureServe Explorer: *Notropis buccula*

Texas State University: <http://www.bio.txstate.edu/~tbonner/txfishes/notropis%20buccula.htm>

TPWD: Rare, Threatened, and Endangered Species of Texas, Smalleye shiner

USFWS: Species Profile Page, Smalleye Shiner (*Notropis buccula*)

USFWS, Species assessment and listing priority (2011): [http://ecos.fws.gov/docs/candidate/assessments/2012/r2/E05Z\\_V01.pdf](http://ecos.fws.gov/docs/candidate/assessments/2012/r2/E05Z_V01.pdf)

USGS: <http://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=589>

**Smooth pimpleback, *Quadrula houstonensis***

NatureServe Explorer: *Quadrula houstonensis*

TPWD: Rare, Threatened, and Endangered Species of Texas, Smooth pimpleback

TPWD, Listing as Threatened: [http://www.tpwd.state.tx.us/huntwild/wild/wildlife\\_diversity/texas\\_rare\\_species/mussels/media/state\\_mussels.pdf](http://www.tpwd.state.tx.us/huntwild/wild/wildlife_diversity/texas_rare_species/mussels/media/state_mussels.pdf)

USFWS: Species Profile Page, Smooth Pimpleback (*Quadrula houstonensis*)

USFWS, Species assessment and listing priority (2012): [http://ecos.fws.gov/docs/candidate/assessments/2013/r2/F04G\\_I01.pdf](http://ecos.fws.gov/docs/candidate/assessments/2013/r2/F04G_I01.pdf)

**Sprague's Pipit, *Anthus spragueii***

Cornell Lab of Ornithology: [http://www.allaboutbirds.org/guide/Spragues\\_Pipit/id](http://www.allaboutbirds.org/guide/Spragues_Pipit/id)

IUCN: <http://www.iucnredlist.org/details/106008459/0>

NatureServe Explorer: *Anthus spragueii*

TPWD: Rare, Threatened, and Endangered Species of Texas, Sprague's Pipit

USFWS: Species Profile Page, Sprague's Pipit (*Anthus spragueii*)

USFWS, Species assessment and listing priority (2012): [http://ecos.fws.gov/docs/candidate/assessments/2013/r6/B0GD\\_V01.pdf](http://ecos.fws.gov/docs/candidate/assessments/2013/r6/B0GD_V01.pdf)

**Texas fatmucket, *Lampsilis bracteata***

NatureServe Explorer: *Lampsilis bracteata*

TPWD: Rare, Threatened, and Endangered Species of Texas, Texas fatmucket

TPWD, Listing as Threatened: [http://www.tpwd.state.tx.us/huntwild/wild/wildlife\\_diversity/texas\\_rare\\_species/mussels/media/state\\_mussels.pdf](http://www.tpwd.state.tx.us/huntwild/wild/wildlife_diversity/texas_rare_species/mussels/media/state_mussels.pdf)

USFWS: Species Profile Page, Texas Fatmucket (*Lampsilis bracteata*)

USFWS, Species assessment and listing priority (2011): [http://ecos.fws.gov/docs/candidate/assessments/2013/r2/F04I\\_I01.pdf](http://ecos.fws.gov/docs/candidate/assessments/2013/r2/F04I_I01.pdf)

**Texas fawnsfoot, *Truncilla macrodon***

NatureServe Explorer: *Truncilla macrodon*

TPWD: Rare, Threatened, and Endangered Species of Texas, Texas fawnsfoot

TPWD, Listing as Threatened: [http://www.tpwd.state.tx.us/huntwild/wild/wildlife\\_diversity/texas\\_rare\\_species/mussels/media/state\\_mussels.pdf](http://www.tpwd.state.tx.us/huntwild/wild/wildlife_diversity/texas_rare_species/mussels/media/state_mussels.pdf)

USFWS: Species Profile Page, Texas Fawnsfoot (*Truncilla macrodon*)

USFWS, Species assessment and listing priority (2011): [http://ecos.fws.gov/docs/candidate/assessments/2013/r2/F04E\\_I01.pdf](http://ecos.fws.gov/docs/candidate/assessments/2013/r2/F04E_I01.pdf)

**Texas pimpleback, *Quadrula petrina***

NatureServe Explorer: *Quadrula petrina*

TPWD: Rare, Threatened, and Endangered Species of Texas, Texas pimpleback

TPWD, Listing as Threatened: [http://www.tpwd.state.tx.us/huntwild/wild/wildlife\\_diversity/texas\\_rare\\_species/mussels/media/state\\_mussels.pdf](http://www.tpwd.state.tx.us/huntwild/wild/wildlife_diversity/texas_rare_species/mussels/media/state_mussels.pdf)

USFWS: Species Profile Page, Texas Pimpleback (*Quadrula petrina*)

USFWS, Species assessment and listing priority (2012): [http://ecos.fws.gov/docs/candidate/assessments/2013/r2/F04F\\_I01.pdf](http://ecos.fws.gov/docs/candidate/assessments/2013/r2/F04F_I01.pdf)

**Texas snowbells, *Styrax platanifolius* ssp. *texanus***

NatureServe Explorer: *Styrax platanifolius* ssp. *texanus*

TPWD: Rare, Threatened, and Endangered Species of Texas, Texas snowbells

TPWD, Wildlife Fact Sheets: <http://www.tpwd.state.tx.us/huntwild/wild/species/snowbell/>

University of Texas Native Plant Database: [http://www.wildflower.org/plants/result.php?id\\_plant=STPLT](http://www.wildflower.org/plants/result.php?id_plant=STPLT)

USDA Plants Profile: <http://plants.usda.gov/java/profile?symbol=STPLT>

USFWS: Species Profile Page, Texas snowbells (*Styrax texanus*)

USFWS, 5-year Review (2008): [http://ecos.fws.gov/docs/five\\_year\\_review/doc2003.pdf](http://ecos.fws.gov/docs/five_year_review/doc2003.pdf)

**Tobusch fishhook cactus, *Sclerocactus brevihamatus* ssp. *tobuschii***

NatureServe Explorer: *Sclerocactus brevihamatus* ssp. *tobuschii*

TPWD: Rare, Threatened, and Endangered Species of Texas, Tobusch fishhook cactus

TPWD, Wildlife Fact Sheets: <http://www.tpwd.state.tx.us/huntwild/wild/species/tobusch/>

University of Texas Native Plant Database: [http://www.wildflower.org/plants/result.php?id\\_plant=SCBRT](http://www.wildflower.org/plants/result.php?id_plant=SCBRT)

USDA Plants Profile: <http://plants.usda.gov/java/profile?symbol=SCBRT>

USFWS: Species Profile Page, Tobusch fishhook cactus (*Sclerocactus brevihamatus* ssp. *tobuschii*)

USFWS, 5-year Review (2010): [http://ecos.fws.gov/docs/five\\_year\\_review/doc3073.pdf](http://ecos.fws.gov/docs/five_year_review/doc3073.pdf)

**Whooping crane, *Grus americana***

Campbell 2003: [http://www.tpwd.state.tx.us/publications/pwdpubs/media/pwd\\_bk\\_w7000\\_0013\\_whooping\\_crane.pdf](http://www.tpwd.state.tx.us/publications/pwdpubs/media/pwd_bk_w7000_0013_whooping_crane.pdf)

Cornell Lab of Ornithology: [http://www.allaboutbirds.org/guide/Whooping\\_Crane/id](http://www.allaboutbirds.org/guide/Whooping_Crane/id)

IUCN: <http://www.iucnredlist.org/details/106002796/0>

NatureServe Explorer: *Grus americana*

TPWD: Rare, Threatened, and Endangered Species of Texas, Whooping Crane

TPWD, Wildlife Fact Sheets: <http://www.tpwd.state.tx.us/huntwild/wild/species/whooper/>

USFWS: Species Profile Page, Whooping crane (*Grus americana*)

USFWS, 5-year Review (2012): [http://ecos.fws.gov/docs/five\\_year\\_review/doc3977.pdf](http://ecos.fws.gov/docs/five_year_review/doc3977.pdf)

**Wood stork, *Mycteria americana***

Cornell Lab of Ornithology: [http://www.allaboutbirds.org/guide/Wood\\_Stork/id](http://www.allaboutbirds.org/guide/Wood_Stork/id)

IUCN: <http://www.iucnredlist.org/details/106003824/0>

NatureServe Explorer: *Mycteria americana*

TPWD: Rare, Threatened, and Endangered Species of Texas, Wood Stork

USFWS: Species Profile Page, Wood stork (*Mycteria americana*)

USFWS, 5-year Review (2007): [http://ecos.fws.gov/docs/five\\_year\\_review/doc1115.pdf](http://ecos.fws.gov/docs/five_year_review/doc1115.pdf)

USFWS, Reclassification of the Continental U.S. Breeding Population of the Wood Stork From Endangered to Threatened: <http://www.gpo.gov/fdsys/pkg/FR-2012-12-26/pdf/2012-30731.pdf>

**Table A.2.**

Additional state-listed species and species under review (indicated by asterisk) for federal listing or recently petitioned.

Species	Taxon, State status	Texas distribution	County-level distribution (approx) for CTGCP Plan Area	Habitat (relative to CTGCP)	Threat	Range map Figure #; data source
False spike, <i>Quadrula mitchelli</i>	Mussel, T*	known from Guadalupe (near Gonzales) and San Saba Rivers (near San Saba)	Bandera, Bell, Bexar, Blanco, Bosque, Burnet, Comal, Coryell, Erath, Gillespie, Hamilton, Hays, Hill, Hood, Johnson, Kendall, Kerr, Kimble, Lampasas, Llano, Mason, McLennan, Medina, Menard, San Saba, Somervell, Travis, Williamson	largely unknown, substrates varying from mud through mixtures of sand, gravel and cobble	impoundments, sedimentation, dewatering, sand and gravel mining, chemical contaminants	A.8; C. Randklev
Louisiana pigtoe, <i>Pleurobema riddellii</i>	Mussel, T*	known from parts of east Texas rivers	Dallas	not well known; streams and moderate-size rivers, usually flowing water on substrates of mud, sand, and gravel; not generally known from impoundments	impoundments, sedimentation, dewatering, sand and gravel mining, chemical contaminants	A.8; C. Randklev
Mexican fawnsfoot, <i>Truncilla cognata</i>	Mussel, T*	known from Rio Grande (Maverick and Webb counties)	Kinney (Rio Grande River)	largely unknown; possibly needs flowing streams and rivers with sand or gravel bottoms based on related species needs	impoundments, sedimentation, dewatering, sand and gravel mining, chemical contaminants	A.8; C. Randklev
Salina mucket, <i>Potamilus metnecktayi</i>	Mussel, T*	known from Rio Grande, possibly lower Pecos	Kinney (Rio Grande River)	not well known; lotic waters; submerged soft sediment (clay and silt) along river bank	impoundments, sedimentation, dewatering, sand and gravel mining, chemical contaminants	A.8; C. Randklev
Texas heelsplitter, <i>Potamilus amphichaenus</i>	Mussel, T*	known from parts of east Texas rivers	Dallas, Jack	not well known; quiet waters in mud or sand and also in reservoirs	impoundments, sedimentation, dewatering, sand and gravel mining, chemical contaminants	A.8; C. Randklev
Blue sucker, <i>Cycleptus elongatus</i>	Fish, T	occurs in limited numbers in several major rivers; Rio Grande distribution unclear	possibly Comal, Kinney, McLennan, Medina, Travis	usually in channels and flowing pools with a moderate current; bottom type usually exposed bedrock, perhaps along with hard clay, sand, and gravel	decreased by impoundment, pollution, and reduced water flows in those systems in which it occurs	A.5; NatureServe
Chihuahua catfish,	Fish*	Rio Grande and Rio Conchos of Texas/Mexico	possibly Kinney (Rio Grande River)	freshwater, unknown	may have been impacted by irrigation and indiscriminant	A.5; NatureServe

<i>Ictalurus</i> sp 1					stockings of channel catfish	
Proserpine shiner, <i>Cyprinella proserpina</i>	Fish, T	Devils and lower Pecos rivers, Las Moras, Pinto, and San Felipe creeks, and Independence Creek in western Texas	Kinney	rocky runs and pools of creeks and small rivers	small geographic range, decreased spring flows, habitat loss and fragmentation, and alteration of flow regimes	A.5; NatureServe
Rio Grande darter, <i>Etheostoma grahami</i>	Fish, T	restricted to the mainstream and spring-fed tributaries of the Rio Grande and lower Pecos River downstream to Devils River and Dolan, San Felipe, and Sycamore creeks	Kinney	gravel and rubble riffles of creeks and small rivers	low overall abundance; vulnerable to local reductions in water flow	A.5; NatureServe
Cascade caverns salamander, <i>Eurycea latitans</i>	Amphibian, T*	less than 10 springs in Kerr, Kendall, Comal, (maybe Hays?)	Bandera, Bexar, Comal, Kendall, Kerr, possibly Hays	subaquatic; springs and caves	small range and severely fragmented distribution, loss of springflows and declining water quality	A.5; NatureServe
Comal blind salamander, <i>Eurycea tridentifera</i>	Amphibian, T*	less than 10 springs in Kendall, Comal, Bexar	Bexar, Comal, Kendall	semi-troglobitic; found in springs and waters of caves	groundwater withdrawal and groundwater contamination	A.5; NatureServe
Texas salamander, <i>Eurycea neotenes</i>	Amphibian*	Helotes Creek Spring, Leon Springs, and Mueller's Spring	Bexar, Kendall	troglobitic; springs, seeps, cave streams, and creek headwaters	drought	A.5; NatureServe
Alligator snapping turtle, <i>Macrochelys temminckii</i>	Reptile, T*	east Texas	Dallas	deep water of rivers, canals, lakes, oxbows; also swamps, bayous, and ponds near deep running water; usually in water with mud bottom and abundant aquatic vegetation	water pollution, siltation, dredging, dams, overutilization	A.6; <a href="http://nas2.er.usgs.gov/view/omap.aspx?SpeciesID=1227">http://nas2.er.usgs.gov/view/omap.aspx?SpeciesID=1227</a>
Brazos water snake, <i>Nerodia harteri</i>	Reptile, T	upper Brazos River drainage	Bosque, Erath, Hill, Hood, Johnson, Palo Pinto, Somervell, Stephens, Young	TPWD = in shallow water with rocky bottom and on rocky portions of banks	limited range	A.6; TPWD and <a href="http://herpetology.tamu.edu/files/2012/07/Scott_eta1_1989_Nerodia-harteri.pdf">http://herpetology.tamu.edu/files/2012/07/Scott_eta1_1989_Nerodia-harteri.pdf</a>
Cagle's map turtle, <i>Graptemys</i>	Reptile, T	Guadalupe River system; segments of the Guadalupe and San Marcos rivers	Comal, Hays, Kendall, Kerr	shallow water with swift to moderate flow and gravel or cobble bottom, connected by	habitat loss due to reservoir construction, water diversions, water quality degradation,	A.6; NatureServe

<i>caglei</i>				deeper pools with a slower flow rate and a silt or mud bottom	siltation and human depredation	
Reticulate collared lizard, <i>Crotaphytus reticulatus</i>	Reptile, T*	occurs only in south Texas from Hidalgo County northward through Maverick and Uvalde Counties	Kinney, Uvalde	open brush-grasslands; thorn-scrub vegetation, usually on well-drained rolling terrain of shallow gravel, caliche, or sandy soils; often on scattered flat rocks below escarpments or isolated rock outcrops among scattered clumps of prickly pear and mesquite	habitat alteration, particularly land clearing practices, the conversion of native grazing lands to farms and improved pastures, and planting exotic mat-forming grasses for livestock grazing	A.6; TPWD, Montanucci paper, and <a href="http://southwesternherp.com/lizards/reticulatus.html">http://southwesternherp.com/lizards/reticulatus.html</a>
Spot-tailed earless lizard, <i>Holbrookia lacerata</i>	Reptile*	central and southern Texas and adjacent Mexico	Bandera, Bexar, Blanco, Burnet, Comal, Edwards, Gillespie, Hays, Kendall, Kerr, Kimble, Kinney, Llano, Mason, Medina, Menard, Real, San Saba, Travis, Uvalde, Williamson	moderately open prairie-brushland; fairly flat areas free of vegetation or other obstructions, including disturbed areas	agricultural herbicides and insecticides; loss of habitat and habitat fragmentation due to conversion to agriculture, sown to exotic grasses for improved grazing, or fragmented by road construction	A.6; TPWD
Texas horned lizard, <i>Phrynosoma cornutum</i>	Reptile, T	statewide	all	open, arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky	may be related to fire ants, use of insecticides to control fire ants, heavy agricultural use of land and/or other habitat alterations, and overcollecting for the pet trade	A.6; FWS species profile
Texas indigo snake, <i>Drymarchon melanurus erebennus</i>	Reptile, T	south of the Guadalupe River and Balcones Escarpment	Bexar, Edwards, Kinney, Medina, Real, Uvalde	thornbush-chaparral woodlands, in particular dense riparian corridors	habitat loss due to human development	A.6; TPWD, <a href="http://www.rw.ttu.edu/sp_accounts/Indigo%20Snake/Distribution.htm">http://www.rw.ttu.edu/sp_accounts/Indigo%20Snake/Distribution.htm</a>
Texas tortoise, <i>Gopherus berlandieri</i>	Reptile, T	southern Texas (generally south of a line connecting Del Rio, San Antonio, and Rockport), south through eastern Coahuila and Nuevo Leon into San Luis Potosi, Mexico	Bexar, Edwards, Kinney, Medina, Uvalde	open brush with a grass understory is preferred; open grass and bare ground are avoided	habitat alterations associated with agriculture or grazing improvements (introduction of buffel grass)	A.6; TPWD, <a href="http://southwesternherp.com/turtles/berlandieri.html">http://southwesternherp.com/turtles/berlandieri.html</a>
Timber/Caneb rake rattlesnake, <i>Crotalus</i>	Reptile, T	eastern third of Texas	Bell, Bosque, Coryell, Dallas, Hill, Hood, Johnson, McLennan, Somervell, Williamson	swamps, floodplains, upland pine and deciduous woodlands, riparian zones, abandoned farmland; limestone bluffs,	loss of habitat; habitat fragmentation and isolation of populations; direct mortality caused by humans and vehicles	A.6; TPWD, IUCN shpfl ( <a href="http://www.iucnredlist.org/techni">www.iucnredlist.org/techni</a> )



<i>horridus</i>				sandy soil or black clay; prefers dense ground cover	as habitat is encroached upon by urban/residential development	cal-documents/spatial-data)
Western chicken turtle, <i>Deirochelys reticularia miaria</i>	Reptile*	eastern third of Texas	Dallas, McLennan, Williamson	found primarily in still waters of ponds, lakes, ditches, marshes, cypress swamps, and bays	habitat loss, losses to automobile collisions during migration, and loss of foraging areas	A.6; <a href="http://www.texasturtles.org/Deirochelys_reticularia_miaria.html">http://www.texasturtles.org/Deirochelys_reticularia_miaria.html</a>
American peregrine falcon, <i>Falco peregrinus anatum</i>	Bird, T	migrant statewide; breeds in west Texas and winters along the coast	migrant = all	(migrant) nearly any open habitat, but greater likelihood along barrier islands, mudflats, coastlines, lake edges	human disturbance, pesticides, potential changes in food availability	A.3; TOS/TPWD
Bald eagle, <i>Haliaeetus leucocephalus</i>	Bird, T	wintering populations are primarily in the Panhandle, Central, and East Texas, and in other areas of suitable habitat throughout the state	winter/migrant = all except Bandera, Bexar, Edwards, Kinney, Medina, Real, Uvalde	(winter/migrant) primarily near rivers and large lakes; forested areas adjacent to large bodies of water; dry, open uplands if there is access to open water	habitat loss; clearing of riparian areas, mature floodplain forests, and water edge trees	A.3; TOS/TPWD
White-faced ibis, <i>Plegadis chihi</i>	Bird, T	migrant statewide; breed and winter along the Gulf Coast	migrant = all	migration = freshwater marshes, sloughs, and irrigated rice fields, but will attend brackish and saltwater habitats	limited breeding locations; vulnerable to fluctuating water levels; susceptible to breeding failure in areas of pesticide contamination	A.3; TOS/TPWD
Zone-tailed hawk, <i>Buteo albonotatus</i>	Bird, T	central Trans-Pecos through southern Edwards Plateau	Bandera, Bexar, Blanco, Comal, Edwards, Gillespie, Hays, Kendall, Kerr, Kimble, Kinney, Llano, Mason, Medina, Menard, Real, San Saba, Uvalde	breeding = arid open country, including open deciduous or pine-oak woodland, mesa or mountain country, often near watercourses, and wooded canyons and tree-lined rivers along middle-slopes of desert mountains	loss of riparian nesting habitat; presence of DDT in several river systems is a concern in southwestern Texas (where contamination of lizard prey is documented)	A.3; TOS/TPWD
Texas kangaroo rat, <i>Dipodomys elator</i>	Mammal, T*	north-central Texas from Cottle and Motley counties in the west to Montague County in the east	Jack, Young	mesquite not required, but mostly in association with scattered mesquite shrubs and sparse, short grasses in areas underlain by firm clay soils; along fencerows adjacent to cultivated fields/roads	loss of burrowing habitat and genetic isolation of populations due to the conversion of native rangeland to agricultural cropland	A.7; <a href="http://www.nsr.ttu.edu/tmot1/images/dmap147.jpg">http://www.nsr.ttu.edu/tmot1/images/dmap147.jpg</a>
Big red sage, <i>Salvia penstemonoid</i>	Plant*	~6 extant populations in Edwards Plateau	Bandera, Bexar, Gillespie, Kendall, Kerr, Real, Uvalde	moist to seasonally wet, steep limestone outcrops on seeps within canyons or along creek	small population size, herbicides, lowering water table, grazing, collecting,	A.7; TPWD

es				banks; occasionally on clayey to silty soils of creek banks and terraces, in partial shade to full sun	erosion	
Correll's false dragon-head, <i>Physostegia correllii</i>	Plant*	<15 occurrences in southern half of Texas	Bexar, Gillespie, Kinney, Travis	wet, silty clay loams on streambanks, in creek beds, irrigation channels, roadside drainage ditches; seepy, mucky, sometimes gravelly soils along riverbanks or small islands in the Rio Grande; underlain by Austin Chalk limestone along gently flowing spring-fed creek in central TX	road widening, weed control and drainage alterations; lack of genetic diversity in clones; scattered distribution of small numbers of known populations	A.7; TPWD
Moss (no name), <i>Donrichardia macroneuron</i>	Plant*	known from only one location at Seven Hundred Springs in Edwards County	Edwards	shaded limestone rocks partially submerged in rapidly flowing relatively thermally constant water at a spring complex	one known occurrence; threatened by drought or changes in hydrology such as a rise in water level	A.7; <a href="http://www.anyplaceamerica.com/topographic_maps/texas/edwards_county/seven_hundred_springs/213-10724/">http://www.anyplaceamerica.com/topographic_maps/texas/edwards_county/seven_hundred_springs/213-10724/</a>
Hall's pocket moss, <i>Fissidens hallii</i>	Plant*	possibly Uvalde?	Uvalde?	grows on rotten wood, bark at the base of trees, or clay soil in swampy places, especially in cypress swamps	limited distribution	A.7; <a href="http://users.tamuk.edu/kfcmg00/research.htm">http://users.tamuk.edu/kfcmg00/research.htm</a>
Small-headed pipewort, <i>Eriocaulon koernickianum</i>	Plant*	known from a few sites in east TX and Enchanted Rock in Gillespie County	Gillespie	in Gillespie County, on permanently wet or moist hillside seep on decomposing granite gravel and sand among granite outcrops	fire suppression	A.7; Rare Plants of Texas: A Field Guide (Poole et al.)

Data sources:

Website links for additional detail about species' habitat associations, threats, and conservation actions for species listed in Table A.2. Species are listed alphabetically by common name.

**Alligator snapping turtle, *Macrochelys temminckii***

Center for Biological Diversity, Petition to list 53 amphibians and reptiles in the United States as threatened or endangered species under the Endangered

Species Act: [http://www.biologicaldiversity.org/campaigns/amphibian\\_conservation/pdfs/Mega\\_herp\\_petition\\_7-9-2012.pdf](http://www.biologicaldiversity.org/campaigns/amphibian_conservation/pdfs/Mega_herp_petition_7-9-2012.pdf)

Herps of Texas: <http://www.herpssoftexas.org/content/alligator-snapping-turtle>  
IUCN: <http://www.iucnredlist.org/details/12589/0>  
NatureServe Explorer: *Macrochelys temminckii*  
Southwestern Center for Herpetological Research: <http://www.southwesternherp.com/turtles/temminckii.html>  
TPWD: Rare, Threatened, and Endangered Species of Texas, Alligator snapping turtle  
USFWS: Species Profile Page, Alligator Snapping turtle (*Macrochelys temminckii*)  
USGS: <http://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=1227>

**American peregrine falcon, *Falco peregrinus anatum*** (delisted at federal level)  
Campbell 2003: [http://www.tpwd.state.tx.us/publications/pwdpubs/media/pwd\\_bk\\_w7000\\_0013\\_peregrine\\_falcon.pdf](http://www.tpwd.state.tx.us/publications/pwdpubs/media/pwd_bk_w7000_0013_peregrine_falcon.pdf)  
Cornell Lab of Ornithology: [http://www.allaboutbirds.org/guide/Peregrine\\_Falcon/lifehistory](http://www.allaboutbirds.org/guide/Peregrine_Falcon/lifehistory)  
NatureServe Explorer: *Falco peregrinus anatum*  
TPWD: Rare, Threatened, and Endangered Species of Texas, American Peregrine Falcon  
TPWD, Wildlife Fact Sheets: <http://www.tpwd.state.tx.us/huntwild/wild/species/amperegrine/>  
USFWS: Species Profile Page, American Peregrine falcon (*Falco peregrinus anatum*)

**Bald eagle, *Haliaeetus leucocephalus*** (delisted at federal level)  
Campbell 2003, species description: [http://www.tpwd.state.tx.us/publications/pwdpubs/media/pwd\\_bk\\_w7000\\_0013\\_bald\\_eagle.pdf](http://www.tpwd.state.tx.us/publications/pwdpubs/media/pwd_bk_w7000_0013_bald_eagle.pdf)  
Campbell 2003, management guidelines: <http://www.savethelampasas.org/Bald%20Eagle%20Management.pdf>  
Cornell Lab of Ornithology: [http://www.allaboutbirds.org/guide/bald\\_eagle/id](http://www.allaboutbirds.org/guide/bald_eagle/id)  
IUCN: <http://www.iucnredlist.org/details/106003365/0>  
NatureServe Explorer: *Haliaeetus leucocephalus*  
TPWD: Rare, Threatened, and Endangered Species of Texas, Bald Eagle  
TPWD, Wildlife Fact Sheets: <http://www.tpwd.state.tx.us/huntwild/wild/species/baldeagle/>  
USFWS: Species Profile Page, Bald eagle (*Haliaeetus leucocephalus*)

**Blue sucker, *Cycleptus elongatus***  
IUCN: <http://www.iucnredlist.org/details/6006/0>  
NatureServe Explorer: *Cycleptus elongatus*  
Texas State University: <http://www.bio.txstate.edu/~tbonner/txfishes/cycleptus%20elongatus.htm>  
TPWD: Rare, Threatened, and Endangered Species of Texas, Blue sucker  
USFWS: Species Profile Page, Blue sucker (*Cycleptus elongatus*)

**Big red sage, *Salvia pentstemonoides* (may also be written as *S. penstemonoides*)**  
NatureServe Explorer: *Salvia pentstemonoides*  
TPWD: Rare, Threatened, and Endangered Species of Texas, Big red sage  
University of Texas Native Plant Database: [http://www.wildflower.org/plants/result.php?id\\_plant=SAPE6](http://www.wildflower.org/plants/result.php?id_plant=SAPE6)  
USDA Plants Profile: <http://plants.usda.gov/java/profile?symbol=sape6>  
USFWS: Species Profile Page, Big Red sage (*Salvia penstemonoides*)

USFWS, Partial 90-Day Finding on a Petition to List 475 Species in the Southwestern United States as Threatened or Endangered with Critical Habitat:  
<http://www.gpo.gov/fdsys/pkg/FR-2009-12-16/pdf/E9-29699.pdf#page=1>

**Brazos water snake, *Nerodia harteri***

Herps of Texas: <http://www.herpssoftexas.org/content/brazos-river-watersnake>

IUCN: <http://www.iucnredlist.org/details/62238/0>

NatureServe Explorer: *Nerodia harteri*

TPWD: Rare, Threatened, and Endangered Species of Texas, Brazos water snake

USFWS: Species Profile Page, Brazos Water snake (*Nerodia harteri harteri*)

**Cagle's map turtle, *Graptemys caglei***

Herps of Texas: <http://www.herpssoftexas.org/content/cagles-map-turtle>

IUCN: <http://www.iucnredlist.org/details/9497/0>

NatureServe Explorer: *Graptemys caglei*

Southwestern Center for Herpetological Research: <http://www.southwesternherp.com/turtles/caglei.html>

TPWD: Rare, Threatened, and Endangered Species of Texas, Cagle's map turtle

USFWS: Species Profile Page, Cagle's Map turtle (*Graptemys caglei*)

West Texas A&M University: [http://www.edwardsaquifer.org/files/Cagles\\_Ma\\_Turtle\\_Final\\_Report.pdf](http://www.edwardsaquifer.org/files/Cagles_Ma_Turtle_Final_Report.pdf)

**Cascade caverns salamander, *Eurycea latitans***

AmphibiaWeb: [http://amphibiaweb.org/cgi/amphib\\_query?where-genus=Eurycea&where-species=latitans](http://amphibiaweb.org/cgi/amphib_query?where-genus=Eurycea&where-species=latitans)

Bendik 2006 Thesis: <http://www.eahcp.org/files/admin-records/NEPA-and-HCP/Bendik,%202006.pdf>

Center for Biological Diversity, Petition to list 53 amphibians and reptiles in the United States as threatened or endangered species under the Endangered

Species Act: [http://www.biologicaldiversity.org/campaigns/amphibian\\_conservation/pdfs/Mega\\_herp\\_petition\\_7-9-2012.pdf](http://www.biologicaldiversity.org/campaigns/amphibian_conservation/pdfs/Mega_herp_petition_7-9-2012.pdf)

Herps of Texas: <http://www.herpssoftexas.org/content/cascade-caverns-salamander>

IUCN: <http://www.iucnredlist.org/details/59267/0>

NatureServe Explorer: *Eurycea latitans*

TPWD: Rare, Threatened, and Endangered Species of Texas, Cascade Caverns salamander

USFWS: Species Profile Page, Cascade Caverns salamander (*Eurycea latitans*)

**Chihuahua catfish, *Ictalurus sp 1***

NatureServe Explorer: *Ictalurus sp. 1*

Texas State University: <http://www.bio.txstate.edu/~tbonner/txfishes/ictalurus%20sp.htm>

TPWD: Rare, Threatened, and Endangered Species of Texas, Chihuahua catfish

USFWS: Species Profile Page, Chihuahua catfish (*Ictalurus sp.*)

USFWS, Partial 90-Day Finding on a Petition to List 475 Species in the Southwestern United States as Threatened or Endangered with Critical Habitat:

<http://www.gpo.gov/fdsys/pkg/FR-2009-12-16/pdf/E9-29699.pdf#page=1>

**Comal blind salamander, *Eurycea tridentifera***

AmphibiaWeb: [http://amphibiaweb.org/cgi/amphib\\_query?where-genus=Eurycea&where-species=tridentifera](http://amphibiaweb.org/cgi/amphib_query?where-genus=Eurycea&where-species=tridentifera)

Bendik 2006 Thesis: <http://www.eahcp.org/files/admin-records/NEPA-and-HCP/Bendik,%202006.pdf>

Herps of Texas: <http://www.herpssoftexas.org/content/comal-blind-salamander>

IUCN: <http://www.iucnredlist.org/details/8393/0>

NatureServe Explorer: *Eurycea tridentifera*

TPWD: Rare, Threatened, and Endangered Species of Texas, Comal blind salamander

USFWS: Species Profile Page, Comal Blind salamander (*Eurycea tridentifera*)

USFWS, Partial 90-Day Finding on a Petition to List 475 Species in the Southwestern United States as Threatened or Endangered with Critical Habitat:

<http://www.gpo.gov/fdsys/pkg/FR-2009-12-16/pdf/E9-29699.pdf#page=1>

### **Correll's false dragon-head, *Physostegia correllii***

Center for Biological Diversity, Petition to list 404 aquatic, riparian, and wetland species from the southwestern United States as threatened or endangered under the Endangered Species Act:

[http://www.biologicaldiversity.org/programs/biodiversity/1000\\_species/the\\_southeast\\_freshwater\\_extinction\\_crisis/pdfs/SE\\_Petition.pdf](http://www.biologicaldiversity.org/programs/biodiversity/1000_species/the_southeast_freshwater_extinction_crisis/pdfs/SE_Petition.pdf)

NatureServe Explorer: *Physostegia correllii*

TPWD: Rare, Threatened, and Endangered Species of Texas, Correll's false dragon-head

University of Texas Native Plant Database: [http://www.wildflower.org/plants/result.php?id\\_plant=PHCO17](http://www.wildflower.org/plants/result.php?id_plant=PHCO17)

USDA Plants Profile: <http://plants.usda.gov/java/profile?symbol=PHCO17>

USFWS: Species Profile Page, Correll's false dragon-head (*Physostegia correllii*)

### **False spike, *Quadrula mitchelli***

NatureServe Explorer: *Quadrula mitchelli*

TPWD: Rare, Threatened, and Endangered Species of Texas, False spike mussel

TPWD, Listing as Threatened: [http://www.tpwd.state.tx.us/huntwild/wild/wildlife\\_diversity/texas\\_rare\\_species/mussels/media/state\\_mussels.pdf](http://www.tpwd.state.tx.us/huntwild/wild/wildlife_diversity/texas_rare_species/mussels/media/state_mussels.pdf)

USFWS, 90-Day Finding on Petitions To List Nine Species of Mussels From Texas as Threatened or Endangered With Critical Habitat:

<http://www.gpo.gov/fdsys/pkg/FR-2009-12-15/pdf/E9-29698.pdf#page=1>

### **Hall's pocket moss, *Fissidens hallii***

Center for Biological Diversity, Petition to list 404 aquatic, riparian, and wetland species from the southwestern United States as threatened or endangered under the Endangered Species Act:

[http://www.biologicaldiversity.org/programs/biodiversity/1000\\_species/the\\_southeast\\_freshwater\\_extinction\\_crisis/pdfs/SE\\_Petition.pdf](http://www.biologicaldiversity.org/programs/biodiversity/1000_species/the_southeast_freshwater_extinction_crisis/pdfs/SE_Petition.pdf)

NatureServe Explorer: *Fissidens hallii*

USDA Plants Profile: <http://plants.usda.gov/java/profile?symbol=FIHA5>

### **Louisiana pigtoe, *Pleurobema riddellii***

NatureServe Explorer: *Pleurobema riddellii*

TPWD: Rare, Threatened, and Endangered Species of Texas, Louisiana pigtoe

TPWD, Listing as Threatened: [http://www.tpwd.state.tx.us/huntwild/wild/wildlife\\_diversity/texas\\_rare\\_species/mussels/media/state\\_mussels.pdf](http://www.tpwd.state.tx.us/huntwild/wild/wildlife_diversity/texas_rare_species/mussels/media/state_mussels.pdf)

USFWS, Partial 90-Day Finding on a Petition to List 475 Species in the Southwestern United States as Threatened or Endangered with Critical Habitat:  
<http://www.gpo.gov/fdsys/pkg/FR-2009-12-16/pdf/E9-29699.pdf#page=1>

**Mexican fawnsfoot, *Truncilla cognata***

NatureServe Explorer: *Truncilla cognata*

TPWD: Rare, Threatened, and Endangered Species of Texas, Mexican fawnsfoot mussel

TPWD, Listing as Threatened: [http://www.tpwd.state.tx.us/huntwild/wild/wildlife\\_diversity/texas\\_rare\\_species/mussels/media/state\\_mussels.pdf](http://www.tpwd.state.tx.us/huntwild/wild/wildlife_diversity/texas_rare_species/mussels/media/state_mussels.pdf)

USFWS: Species Profile Page, Mexican fawnsfoot (*Truncilla cognata*)

USFWS, 90-Day Finding on Petitions To List Nine Species of Mussels From Texas as Threatened or Endangered With Critical Habitat:  
<http://www.gpo.gov/fdsys/pkg/FR-2009-12-15/pdf/E9-29698.pdf#page=1>

**Moss (no name), *Donrichardsia macroneuron***

IUCN: <http://www.iucnredlist.org/details/39166/0>

NatureServe Explorer: *Donrichardsia macroneuron*

TPWD: Rare, Threatened, and Endangered Species of Texas, Don Richard's spring moss

USDA Plants Profile: <http://plants.usda.gov/java/nameSearch?mode=sciname&keywordquery=Eurhynchium+macroneuron>

USFWS, Partial 90-Day Finding on a Petition to List 475 Species in the Southwestern United States as Threatened or Endangered with Critical Habitat:  
<http://www.gpo.gov/fdsys/pkg/FR-2009-12-16/pdf/E9-29699.pdf#page=1>

**Proserpine shiner, *Cyprinella proserpina***

IUCN: <http://www.iucnredlist.org/details/6139/0>

NatureServe Explorer: *Cyprinella proserpina*

Texas State University: <http://www.bio.txstate.edu/~tbonner/txfishes/cyprinella%20proserpina.htm>

TPWD: Rare, Threatened, and Endangered Species of Texas, Proserpine shiner

USFWS: Species Profile Page, Proserpine shiner (*Cyprinella proserpina*)

**Reticulate collared lizard, *Crotaphytus reticulatus***

Center for Biological Diversity, Petition to list 53 amphibians and reptiles in the United States as threatened or endangered species under the Endangered

Species Act: [http://www.biologicaldiversity.org/campaigns/amphibian\\_conservation/pdfs/Mega\\_herp\\_petition\\_7-9-2012.pdf](http://www.biologicaldiversity.org/campaigns/amphibian_conservation/pdfs/Mega_herp_petition_7-9-2012.pdf)

Herps of Texas: <http://www.herpssoftexas.org/content/reticulate-collared-lizard>

IUCN: <http://www.iucnredlist.org/details/64012/0>

NatureServe Explorer: *Crotaphytus reticulatus*

Southwestern Center for Herpetological Research: <http://www.southwesternherp.com/lizards/reticulatus.html>

TPWD: Rare, Threatened, and Endangered Species of Texas, Reticulate collared lizard

USFWS: Species Profile Page, Reticulate Collared lizard (*Crotaphytus reticulatus*)

**Rio Grande darter, *Etheostoma grahami***

IUCN: <http://www.iucnredlist.org/details/8115/0>

NatureServe Explorer: *Etheostoma grahami*

Texas State University: <http://www.bio.txstate.edu/~tbonner/txfishes/etheostoma%20grahami.htm>

TPWD: Rare, Threatened, and Endangered Species of Texas, Rio Grande darter

USFWS: Species Profile Page, Rio Grande darter (*Etheostoma grahami*)

**Salina mucket, *Potamilus metnecktayi***

NatureServe Explorer: *Potamilus metnecktayi*

TPWD: Rare, Threatened, and Endangered Species of Texas, Salina mucket

TPWD, Listing as Threatened: [http://www.tpwd.state.tx.us/huntwild/wild/wildlife\\_diversity/texas\\_rare\\_species/mussels/media/state\\_mussels.pdf](http://www.tpwd.state.tx.us/huntwild/wild/wildlife_diversity/texas_rare_species/mussels/media/state_mussels.pdf)

USFWS: Species Profile Page, Salina mucket (*Potamilus metnecktayi*)

USFWS, 90-Day Finding on Petitions To List Nine Species of Mussels From Texas as Threatened or Endangered With Critical Habitat:

<http://www.gpo.gov/fdsys/pkg/FR-2009-12-15/pdf/E9-29698.pdf#page=1>

**Small-headed pipewort, *Eriocaulon koernickianum***

Center for Biological Diversity, Petition to list 404 aquatic, riparian, and wetland species from the southwestern United States as threatened or endangered under the Endangered Species Act:

[http://www.biologicaldiversity.org/programs/biodiversity/1000\\_species/the\\_southeast\\_freshwater\\_extinction\\_crisis/pdfs/SE\\_Petition.pdf](http://www.biologicaldiversity.org/programs/biodiversity/1000_species/the_southeast_freshwater_extinction_crisis/pdfs/SE_Petition.pdf)

MacRoberts and MacRoberts 2005, Status and Management of *Eriocaulon koernickianum* in Texas:

[http://ia700709.us.archive.org/17/items/cbarchive\\_41915\\_statusandmanagementoferiocaulo1933/statusandmanagementoferiocaulo1933.pdf](http://ia700709.us.archive.org/17/items/cbarchive_41915_statusandmanagementoferiocaulo1933/statusandmanagementoferiocaulo1933.pdf)

NatureServe Explorer: *Eriocaulon koernickianum*

TPWD: Rare, Threatened, and Endangered Species of Texas, Small-headed pipewort

USDA Plants Profile: <http://plants.usda.gov/java/profile?symbol=ERKO>

**Spot-tailed earless lizard, *Holbrookia lacerata***

Herps of Texas: <http://www.herpssoftexas.org/content/spot-tailed-earless-lizard>

IUCN: <http://www.iucnredlist.org/details/64064/0>

NatureServe Explorer: *Holbrookia lacerata*

TPWD: Rare, Threatened, and Endangered Species of Texas, Spot-tailed earless lizard

USFWS, 90-Day Finding on a Petition To List the Spot-Tailed Earless Lizard as Endangered or Threatened:

[http://www.fws.gov/southwest/es/Documents/R2ES/SpotTailedEarlessLizard\\_90-day\\_FR\\_notice\\_24May2011.pdf](http://www.fws.gov/southwest/es/Documents/R2ES/SpotTailedEarlessLizard_90-day_FR_notice_24May2011.pdf)

WildEarth Guardians, Petition to list the spot-tailed earless lizard (*Holbrookia lacerata*) under the U.S. Endangered Species Act:

[http://www.wildearthguardians.org/legal/listing\\_petition\\_lizard\\_1.13.10.pdf](http://www.wildearthguardians.org/legal/listing_petition_lizard_1.13.10.pdf)

**Texas heelsplitter, *Potamilus amphichaenus***

NatureServe Explorer: *Potamilus amphichaenus*

TPWD: Rare, Threatened, and Endangered Species of Texas, Texas heelsplitter

TPWD, Listing as Threatened: [http://www.tpwd.state.tx.us/huntwild/wild/wildlife\\_diversity/texas\\_rare\\_species/mussels/media/state\\_mussels.pdf](http://www.tpwd.state.tx.us/huntwild/wild/wildlife_diversity/texas_rare_species/mussels/media/state_mussels.pdf)

USFWS: Species Profile Page, Texas heelsplitter (*Potamilus amphichaenus*)

USFWS, 90-Day Finding on Petitions To List Nine Species of Mussels From Texas as Threatened or Endangered With Critical Habitat:

<http://www.gpo.gov/fdsys/pkg/FR-2009-12-15/pdf/E9-29698.pdf#page=1>

**Texas horned lizard, *Phrynosoma cornutum***

Herps of Texas: <http://www.herpssoftexas.org/content/texas-horned-lizard>

IUCN: <http://www.iucnredlist.org/details/64072/0>

NatureServe Explorer: *Phrynosoma cornutum*

Southwestern Center for Herpetological Research: <http://www.southwesternherp.com/lizards/cornutum.html>

TPWD: Rare, Threatened, and Endangered Species of Texas, Texas horned lizard

TPWD, Wildlife Fact Sheets: <http://www.tpwd.state.tx.us/huntwild/wild/species/thlizard/>

USFWS: Species Profile Page, Texas Horned lizard (*Phrynosoma cornutum*)

**Texas indigo snake, *Drymarchon melanurus erebennus***

Herps of Texas: <http://www.herpssoftexas.org/content/western-indigo-snake>

NatureServe Explorer: *Drymarchon melanurus erebennus*

Southwestern Center for Herpetological Research: <http://www.southwesternherp.com/snakes/erebennus.html>

TPWD: Rare, Threatened, and Endangered Species of Texas, Texas indigo snake

**Texas kangaroo rat, *Dipodomys elator***

IUCN: <http://www.iucnredlist.org/details/6675/0>

NatureServe Explorer: *Dipodomys elator*

Texas Tech University Mammals of Texas: <http://www.nsrl.ttu.edu/tmot1/dipoelat.htm>

TPWD: Rare, Threatened, and Endangered Species of Texas, Texas kangaroo rat

TPWD, Wildlife Fact Sheets: <http://www.tpwd.state.tx.us/huntwild/wild/species/kanrat/>

USFWS: Species Profile Page, Texas kangaroo rat (*Dipodomys elator*)

USFWS, 90-Day Finding on a Petition To List the Texas Kangaroo Rat as Endangered or Threatened: <http://www.gpo.gov/fdsys/pkg/FR-2011-03-08/pdf/2011-5177.pdf>

WildEarth Guardians, Petition to list the Texas kangaroo rat (*Dipodomys elator*) under the U.S. Endangered Species Act:

[http://www.wildearthguardians.org/site/DocServer/listing\\_petition\\_tx\\_krat\\_1.11.10.pdf?docID=616&AddInterest=1103](http://www.wildearthguardians.org/site/DocServer/listing_petition_tx_krat_1.11.10.pdf?docID=616&AddInterest=1103)

**Texas salamander, *Eurycea neotenes***

AmphibiaWeb: [http://amphibiaweb.org/cgi-bin/amphib\\_query?where-genus=Eurycea&where-species=neotenes](http://amphibiaweb.org/cgi-bin/amphib_query?where-genus=Eurycea&where-species=neotenes)

Bendik 2006 Thesis: <http://www.eahcp.org/files/admin-records/NEPA-and-HCP/Bendik,%202006.pdf>

Herps of Texas: <http://www.herpssoftexas.org/content/texas-salamander>

IUCN: <http://www.iucnredlist.org/details/59272/0>

NatureServe Explorer: *Eurycea neotenes*

TPWD: Rare, Threatened, and Endangered Species of Texas,

USFWS: Species Profile Page, Texas salamander (*Eurycea neotenes*)

USFWS, Partial 90-Day Finding on a Petition to List 475 Species in the Southwestern United States as Threatened or Endangered with Critical Habitat:

<http://www.gpo.gov/fdsys/pkg/FR-2009-12-16/pdf/E9-29699.pdf#page=1>



**Texas tortoise, *Gopherus berlandieri***

Herps of Texas: <http://www.herpssoftexas.org/content/texas-tortoise>

IUCN: <http://www.iucnredlist.org/details/9401/0>

NatureServe Explorer: *Gopherus berlandieri*

Southwestern Center for Herpetological Research: <http://www.southwesternherp.com/turtles/berlandieri.html>

Texas Tech University: <http://www.nsr.ttu.edu/publications/opapers/ops/op196.pdf>

TPWD: Rare, Threatened, and Endangered Species of Texas, Texas tortoise

TPWD, Wildlife Fact Sheets: <http://www.tpwd.state.tx.us/huntwild/wild/species/txtort/>

**Timber/Canebrake rattlesnake, *Crotalus horridus***

Herps of Texas: <http://www.herpssoftexas.org/content/timber-rattlesnake>

IUCN: <http://www.iucnredlist.org/details/64318/0>

NatureServe Explorer: *Crotalus horridus*

Southwestern Center for Herpetological Research: <http://www.southwesternherp.com/snakes/horridus.html>

TPWD: Rare, Threatened, and Endangered Species of Texas, Timber/Canebrake rattlesnake

TPWD, Wildlife Fact Sheets: <http://www.tpwd.state.tx.us/huntwild/wild/species/timberrattlesnake/>

USFS, Fire Effects Information System: <http://www.fs.fed.us/database/feis/animals/reptile/crho/all.html>

USFWS: Species Profile Page, Timber rattlesnake (*Crotalus horridus*) (shows it only occurring in Ohio)

**Western chicken turtle, *Deirochelys reticularia miaria***

Center for Biological Diversity, Petition to list 404 aquatic, riparian, and wetland species from the southwestern United States as threatened or endangered under the Endangered Species Act:

[http://www.biologicaldiversity.org/programs/biodiversity/1000\\_species/the\\_southeast\\_freshwater\\_extinction\\_crisis/pdfs/SE\\_Petition.pdf](http://www.biologicaldiversity.org/programs/biodiversity/1000_species/the_southeast_freshwater_extinction_crisis/pdfs/SE_Petition.pdf)

Herps of Texas: <http://www.herpssoftexas.org/content/chicken-turtle>

NatureServe Explorer: *Deirochelys reticularia miaria*

**White-faced ibis, *Plegadis chihi***

Cornell Lab of Ornithology: [http://www.allaboutbirds.org/guide/White-faced\\_Ibis/id](http://www.allaboutbirds.org/guide/White-faced_Ibis/id)

IUCN: <http://www.iucnredlist.org/details/106003778/0>

NatureServe Explorer: *Plegadis chihi*

TPWD: Rare, Threatened, and Endangered Species of Texas, White-faced Ibis

TPWD, Wildlife Fact Sheets: <http://www.tpwd.state.tx.us/huntwild/wild/species/ibis/>

USFWS: Species Profile Page, White-Faced ibis (*Plegadis chihi*)

**Zone-tailed hawk, *Buteo albonotatus***

Cornell Lab of Ornithology: [http://www.allaboutbirds.org/guide/Zone-tailed\\_Hawk/id](http://www.allaboutbirds.org/guide/Zone-tailed_Hawk/id)

IUCN: <http://www.iucnredlist.org/details/106003511/0>

NatureServe Explorer: *Buteo albonotatus*

TPWD: Rare, Threatened, and Endangered Species of Texas, Zone-tailed Hawk

**Table A.3.**

Additional federally-listed species and species of concern that occur in CTGCP Plan Area but outside the Permit Area or that do not realistically occur in CTGCP Plan Area (although they're listed in some state and federal websites). Status abbreviations: FE = Federal Endangered, FT = Federal Threatened, FSAT = Similarity of Appearance (Threatened), SE = State Endangered, ST = State Threatened, C = Candidate, Pr = Proposed for listing, Pe = Petitioned for listing

Species	Taxon; Status	Distribution in CTGCP area	General habitat type
Bee Creek Cave (Reddell) harvestman, <i>Texella reddelli</i>	Arachnid; FE	Travis	Cave
Bone Cave harvestman, <i>Texella reyesi</i>	Arachnid; FE	Travis, Williamson	Cave
Braken Bat Cave Meshweaver, <i>Cicurina venii</i>	Arachnid; FE	Bexar	Cave
Cokendolpher Cave Harvestman, <i>Texella cokendolpheri</i>	Arachnid; FE	Bexar	Cave
Robber Baron Cave meshweaver, <i>Cicurina baronia</i>	Arachnid; FE	Bexar	Cave
Government Canyon Bat Cave Meshweaver, <i>Cicurina vespera</i>	Arachnid; FE	Bexar	Cave
Government Canyon Bat Cave Spider, <i>Neoleptoneta microps</i>	Arachnid; FE	Bexar	Cave
Madla Cave meshweaver, <i>Cicurina madla</i>	Arachnid; FE	Bexar	Cave
Tooth Cave pseudoscorpion, <i>Tartarocreagris texana</i>	Arachnid; FE	Travis	Cave
Tooth Cave spider, <i>Leptoneta (Neoleptoneta) myopica</i>	Arachnid; FE	Travis	Cave
Warton's Cave Meshweaver, <i>Cicurina wartoni</i>	Arachnid; C	Travis	cave
Coffin Cave mold beetle, <i>Batrisodes texanus</i>	Insect; FE	Williamson	Cave
Edwards Aquifer diving beetle, <i>Haideoporus texanus</i>	Insect; Pe	Comal, Hays	underground aquifer
Ground Beetle (no name), <i>Rhadine exilis</i>	Insect; FE	Bexar	Cave
Ground Beetle (no name), <i>Rhadine infernalis</i>	Insect; FE	Bexar	Cave
Helotes Mold Beetle, <i>Batrisodes ventyivi</i>	Insect; FE	Bexar	Cave
Comal Springs dryopid beetle, <i>Stygoparnus comalensis</i>	Insect; FE	Comal, Hays	Cave
Comal Springs riffle beetle, <i>Heterelmis comalensis</i>	Insect; FE	Comal, Hays	freshwater spring
Kretschmarr Cave mold beetle, <i>Texamaurops reddelli</i>	Insect; FE	Travis	Cave
Peck's Cave Amphipod, <i>Stygobromus (Stygonectes) pecki</i>	Insect; FE, SE	Comal	freshwater spring
Tooth Cave ground beetle, <i>Rhadine persephone</i>	Insect; FE	Travis, Williamson	Cave
Texas troglobitic water slater, <i>Lirceolus smithii</i>	Crustacean; Pe	Hays	underground aquifer
Mimic cavesnail, <i>Phreatodrobia imitata</i>	Snail; Pe	Bexar	underground aquifer
Fountain darter, <i>Etheostoma fonticola</i>	Fish; FE, SE	Comal, Hays	freshwater spring
San Marcos gambusia, <i>Gambusia georgei</i>	Fish; FE, SE	Hays	freshwater spring
Toothless blindcat, <i>Trogloglanis pattersoni</i>	Fish; Pe	Bexar	underground aquifer
Widemouth blindcat, <i>Satan eurystomus</i>	Fish; Pe	Bexar	underground aquifer
Austin Blind Salamander, <i>Eurycea waterlooensis</i>	Amphibian; C, Pr	Travis	freshwater spring/cave

Barton Springs salamander, <i>Eurycea sosorum</i>	Amphibian; FE, SE	Hays, Travis	freshwater spring
Blanco blind salamander, <i>Eurycea robusta</i>	Amphibian; Pe	Hays	aquatic cave, spring
Comal Springs salamander, <i>Eurycea</i> sp 8	Amphibian; Pe	Comal	freshwater spring
Georgetown Salamander, <i>Eurycea naufragia</i>	Amphibian; C, Pr	Williamson	freshwater spring/cave
Jollyville Plateau Salamander, <i>Eurycea tonkawae</i>	Amphibian; C, Pr	Travis, Williamson	freshwater spring/cave
San Marcos salamander, <i>Eurycea nana</i>	Amphibian; FT, ST	Hays	freshwater spring
Texas blind salamander, <i>Typhlomolge (Eurycea) rathbuni</i>	Amphibian; FE, SE	Hays	aquatic cave
Black bear, <i>Ursus americanus</i>	Mammal; FSAT, ST	(unlikely in GCP area, J.Evans)	woodland
Gray wolf, <i>Canis lupus</i>	Mammal; FE, SE	(unlikely in GCP area, J.Evans)	general
Jaguarundi, <i>Herpailurus yaguarondi</i>	Mammal; FE, SE	(unlikely in GCP area, J.Evans)	woodland, shrubland
Ocelot, <i>Leopardus pardalis</i>	Mammal; FE, SE	(unlikely in GCP area, J.Evans)	woodland, shrubland
Red wolf, <i>Canis rufus</i>	Mammal; FE, SE	(unlikely in GCP area, J.Evans)	woodland, wetland
White-nosed coati, <i>Nasua narica</i>	Mammal; ST	(unlikely in GCP area, J.Evans)	woodland, shrubland, cropland
Texas wild-rice, <i>Zizania texana</i>	Mammal; FE, SE	Hays	freshwater spring

**Table A.4.**

Listed species or species of concern (from Tables 1 and 2) listed by county. Includes counties in the CTGCP Permit Area. Status abbreviations: F = federally listed, S = state listed, C = candidate, Pr = proposed for listing, Pe = petitioned for listing. Yellow highlight indicate federally-listed or candidate species.

Common name	Listing status	Taxon	General habitat
<b>Bandera</b>			
False spike, <i>Quadrula mitchelli</i>	S, Pe	Mussel	river
Texas fatmucket, <i>Lampsilis bracteata</i>	S, C	Mussel	river
Texas pimpleback, <i>Quadrula petrina</i>	S, C	Mussel	river
Cascade caverns salamander, <i>Eurycea latitans</i> complex	S, Pe	Amphibian	aquatic cave
Spot-tailed earless lizard, <i>Holbrookia lacerata</i>	Pe	Reptile	desert, grassland, shrubland, oak-juniper woodlands
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines
Red Knot, <i>Calidris canutus</i> ssp. <i>rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh
Zone-tailed hawk, <i>Buteo albonotatus</i>	S	Bird	(breeding) arid scrub, pine-oak woodlands, cliffs/canyons
Big red sage, <i>Salvia penstemonoides</i>	Pe	Plant	stream banks, limestone ledges
Bracted twistflower, <i>Streptanthus bracteatus</i>	C	Plant	woodland
Tobusch fishhook cactus, <i>Sclerocactus brevihamatus</i> ssp. <i>tobuschii</i>	F, S	Plant	live oak-juniper shrublands
<b>Bell</b>			
False spike, <i>Quadrula mitchelli</i>	S, Pe	Mussel	river
Smooth pimpleback, <i>Quadrula houstonensis</i>	S, C	Mussel	river
Texas fawnsfoot, <i>Truncilla macrodon</i>	S, C	Mussel	river
Salado Salamander, <i>Eurycea chisholmensis</i>	C, Pr	Amphibian	freshwater spring, aquatic cave
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland
Timber/Canebrake rattlesnake, <i>Crotalus horridus</i>	S	Reptile	woodland, wetland
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines
Bald eagle, <i>Haliaeetus leucocephalus</i>	S	Bird	(migrant/winter) woodland, riparian, open water
Red Knot, <i>Calidris canutus</i> ssp. <i>rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh
Whooping crane, <i>Grus americana</i>	F, S	Bird	(migrant) wetland
<b>Blanco</b>			
False spike, <i>Quadrula mitchelli</i>	S, Pe	Mussel	river

Golden orb, <i>Quadrula aurea</i>	S, C	Mussel	river
Smooth pimpleback, <i>Quadrula houstonensis</i>	S, C	Mussel	river
Texas fatmucket, <i>Lampsilis bracteata</i>	S, C	Mussel	river
Texas fawnsfoot, <i>Truncilla macrodon</i>	S, C	Mussel	river
Texas pimpleback, <i>Quadrula petrina</i>	S, C	Mussel	river
Spot-tailed earless lizard, <i>Holbrookia lacerata</i>	Pe	Reptile	desert, grassland, shrubland, oak-juniper woodlands
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines
Bald eagle, <i>Haliaeetus leucocephalus</i>	S	Bird	(migrant/winter) woodland, riparian, open water
Red Knot, <i>Calidris canutus ssp. rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh
Whooping crane, <i>Grus americana</i>	F, S	Bird	(migrant) wetland
Zone-tailed hawk, <i>Buteo albonotatus</i>	S	Bird	(breeding) arid scrub, pine-oak woodlands, cliffs/canyons
<b>Bosque</b>			
False spike, <i>Quadrula mitchelli</i>	S, Pe	Mussel	river
Smooth pimpleback, <i>Quadrula houstonensis</i>	S, C	Mussel	river
Texas fawnsfoot, <i>Truncilla macrodon</i>	S, C	Mussel	river
Sharpnose Shiner, <i>Notropis oxyrhynchus</i>	C	Fish	river
Brazos water snake, <i>Nerodia harteri</i>	S	Reptile	freshwater
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland
Timber/Canebrake rattlesnake, <i>Crotalus horridus</i>	S	Reptile	woodland, wetland
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines
Bald eagle, <i>Haliaeetus leucocephalus</i>	S	Bird	(migrant/winter) woodland, riparian, open water
Red Knot, <i>Calidris canutus ssp. rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh
Whooping crane, <i>Grus americana</i>	F, S	Bird	(migrant) wetland
<b>Burnet</b>			
False spike, <i>Quadrula mitchelli</i>	S, Pe	Mussel	river
Smooth pimpleback, <i>Quadrula houstonensis</i>	S, C	Mussel	river
Texas fatmucket, <i>Lampsilis bracteata</i>	S, C	Mussel	river
Texas fawnsfoot, <i>Truncilla macrodon</i>	S, C	Mussel	river
Texas pimpleback, <i>Quadrula petrina</i>	S, C	Mussel	river
Spot-tailed earless lizard, <i>Holbrookia lacerata</i>	Pe	Reptile	desert, grassland, shrubland, oak-juniper woodlands
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland
American peregrine falcon, <i>Falco</i>	S	Bird	(migrant) open habitat, lake shores, coastlines

<i>peregrinus anatum</i>				
Bald eagle, <i>Haliaeetus leucocephalus</i>	S	Bird	(migrant/winter) woodland, riparian, open water	
Red Knot, <i>Calidris canutus</i> ssp. <i>rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats	
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland	
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh	
Whooping crane, <i>Grus americana</i>	F, S	Bird	(migrant) wetland	
<b>Coryell</b>				
False spike, <i>Quadrula mitchelli</i>	S, Pe	Mussel	river	
Smooth pimpleback, <i>Quadrula houstonensis</i>	S, C	Mussel	river	
Texas fawnsfoot, <i>Truncilla macrodon</i>	S, C	Mussel	river	
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland	
Timber/Canebrake rattlesnake, <i>Crotalus horridus</i>	S	Reptile	woodland, wetland	
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines	
Bald eagle, <i>Haliaeetus leucocephalus</i>	S	Bird	(migrant/winter) woodland, riparian, open water	
Red Knot, <i>Calidris canutus</i> ssp. <i>rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats	
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland	
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh	
Whooping crane, <i>Grus americana</i>	F, S	Bird	(migrant) wetland	
<b>Dallas</b>				
Louisiana pigtoe, <i>Pleurobema riddellii</i>	S, Pe	Mussel	river	
Texas heelsplitter, <i>Potamilus amphichaenus</i>	S, Pe	Mussel	river	
Alligator snapping turtle, <i>Macrochelys temminckii</i>	S, Pe	Reptile	freshwater	
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland	
Timber/Canebrake rattlesnake, <i>Crotalus horridus</i>	S	Reptile	woodland, wetland	
Western chicken turtle, <i>Deirochelys reticularia miaria</i>	Pe	Reptile	lakes, oxbows, swamps, marshes, ephemeral bodies of water	
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines	
Bald eagle, <i>Haliaeetus leucocephalus</i>	S	Bird	(migrant/winter) woodland, riparian, open water	
Interior least tern, <i>Sterna antillarum athalassos</i>	F, S	Bird	(breeding) barren areas along rivers or coast	
Piping plover, <i>Charadrius melodus</i>	F, S	Bird	(migrant) coastal beaches, mudflats, sandflats	
Red Knot, <i>Calidris canutus</i> ssp. <i>rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats	
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland	
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh	
Whooping crane, <i>Grus americana</i>	F, S	Bird	(migrant) wetland	
Wood stork, <i>Mycteria americana</i>	F, S	Bird	(migrant) wetland, marsh	
<b>Eastland</b>				
Smooth pimpleback, <i>Quadrula houstonensis</i>	S, C	Mussel	river	
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland	

American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines
Bald eagle, <i>Haliaeetus leucocephalus</i>	S	Bird	(migrant/winter) woodland, riparian, open water
Red Knot, <i>Calidris canutus ssp. rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh
Whooping crane, <i>Grus americana</i>	F, S	Bird	(migrant) wetland
<b>Edwards</b>			
Spot-tailed earless lizard, <i>Holbrookia lacerata</i>	Pe	Reptile	desert, grassland, shrubland, oak-juniper woodlands
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland
Texas indigo snake, <i>Drymarchon melanurus erebennus</i>	S	Reptile	mesquite brush near water
Texas tortoise, <i>Gopherus berlandieri</i>	S	Reptile	grassland, shrubland, woodland
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines
Red Knot, <i>Calidris canutus ssp. rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh
Zone-tailed hawk, <i>Buteo albonotatus</i>	S	Bird	(breeding) arid scrub, pine-oak woodlands, cliffs/canyons
Moss (no name), <i>Donrichardsia macroneuron</i>	Pe	Plant	freshwater spring
Texas snowbells, <i>Styrax platanifolius ssp. texanus</i>	F, S	Plant	wooded limestone cliff
Tobusch fishhook cactus, <i>Sclerocactus brevihamatus ssp. tobuschii</i>	F, S	Plant	live oak-juniper shrublands
<b>Erath</b>			
False spike, <i>Quadrula mitchelli</i>	S, Pe	Mussel	river
Smooth pimpleback, <i>Quadrula houstonensis</i>	S, C	Mussel	river
Brazos water snake, <i>Nerodia harteri</i>	S	Reptile	freshwater
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines
Bald eagle, <i>Haliaeetus leucocephalus</i>	S	Bird	(migrant/winter) woodland, riparian, open water
Red Knot, <i>Calidris canutus ssp. rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh
Whooping crane, <i>Grus americana</i>	F, S	Bird	(migrant) wetland
<b>Gillespie</b>			
False spike, <i>Quadrula mitchelli</i>	S, Pe	Mussel	river
Texas fatmucket, <i>Lampsilis bracteata</i>	S, C	Mussel	river
Texas pimpleback, <i>Quadrula petrina</i>	S, C	Mussel	river
Spot-tailed earless lizard, <i>Holbrookia lacerata</i>	Pe	Reptile	desert, grassland, shrubland, oak-juniper woodlands
Texas horned lizard, <i>Phrynosoma</i>	S	Reptile	desert, grassland, shrubland

<i>cornutum</i>			
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines
Bald eagle, <i>Haliaeetus leucocephalus</i>	S	Bird	(migrant/winter) woodland, riparian, open water
Red Knot, <i>Calidris canutus ssp. rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh
Whooping crane, <i>Grus americana</i>	F, S	Bird	(migrant) wetland
Zone-tailed hawk, <i>Buteo albonotatus</i>	S	Bird	(breeding) arid scrub, pine-oak woodlands, cliffs/canyons
Big red sage, <i>Salvia penstemonoides</i>	Pe	Plant	stream banks, limestone ledges
Correll's false dragon-head, <i>Physostegia correllii</i>	Pe	Plant	wetland/riparian
Small-headed pipewort, <i>Eriocaulon koernickianum</i>	Pe	Plant	acidic and sandy hillside seeps
<b>Hamilton</b>			
False spike, <i>Quadrula mitchelli</i>	S, Pe	Mussel	river
Smooth pimpleback, <i>Quadrula houstonensis</i>	S, C	Mussel	river
Texas fawnsfoot, <i>Truncilla macrodon</i>	S, C	Mussel	river
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines
Bald eagle, <i>Haliaeetus leucocephalus</i>	S	Bird	(migrant/winter) woodland, riparian, open water
Red Knot, <i>Calidris canutus ssp. rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh
Whooping crane, <i>Grus americana</i>	F, S	Bird	(migrant) wetland
<b>Hill</b>			
False spike, <i>Quadrula mitchelli</i>	S, Pe	Mussel	river
Smooth pimpleback, <i>Quadrula houstonensis</i>	S, C	Mussel	river
Texas fawnsfoot, <i>Truncilla macrodon</i>	S, C	Mussel	river
Sharpnose Shiner, <i>Notropis oxyrhynchus</i>	C	Fish	river
Brazos water snake, <i>Nerodia harteri</i>	S	Reptile	freshwater
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland
Timber/Canebrake rattlesnake, <i>Crotalus horridus</i>	S	Reptile	woodland, wetland
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines
Bald eagle, <i>Haliaeetus leucocephalus</i>	S	Bird	(migrant/winter) woodland, riparian, open water
Red Knot, <i>Calidris canutus ssp. rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh
Whooping crane, <i>Grus americana</i>	F, S	Bird	(migrant) wetland
Wood stork, <i>Mycteria americana</i>	F, S	Bird	(migrant) wetland, marsh
<b>Hood</b>			



False spike, <i>Quadrula mitchelli</i>	S, Pe	Mussel	river
Smooth pimpleback, <i>Quadrula houstonensis</i>	S, C	Mussel	river
Texas fawnsfoot, <i>Truncilla macrodon</i>	S, C	Mussel	river
Sharpnose Shiner, <i>Notropis oxyrhynchus</i>	C	Fish	river
Brazos water snake, <i>Nerodia harteri</i>	S	Reptile	freshwater
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland
Timber/Canebrake rattlesnake, <i>Crotalus horridus</i>	S	Reptile	woodland, wetland
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines
Bald eagle, <i>Haliaeetus leucocephalus</i>	S	Bird	(migrant/winter) woodland, riparian, open water
Red Knot, <i>Calidris canutus ssp. rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh
Whooping crane, <i>Grus americana</i>	F, S	Bird	(migrant) wetland
<b>Jack</b>			
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines
Bald eagle, <i>Haliaeetus leucocephalus</i>	S	Bird	(migrant/winter) woodland, riparian, open water
Red Knot, <i>Calidris canutus ssp. rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh
Whooping crane, <i>Grus americana</i>	F, S	Bird	(migrant) wetland
Texas kangaroo rat, <i>Dipodomys elator</i>	S, Pe	Mammal	arid areas with short, sparse grasses and little woody canopy cover
<b>Johnson</b>			
Smooth pimpleback, <i>Quadrula houstonensis</i>	S, C	Mussel	river
Texas fawnsfoot, <i>Truncilla macrodon</i>	S, C	Mussel	river
Brazos water snake, <i>Nerodia harteri</i>	S	Reptile	freshwater
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland
Timber/Canebrake rattlesnake, <i>Crotalus horridus</i>	S	Reptile	woodland, wetland
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines
Bald eagle, <i>Haliaeetus leucocephalus</i>	S	Bird	(migrant/winter) woodland, riparian, open water
Red Knot, <i>Calidris canutus ssp. rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh
Whooping crane, <i>Grus americana</i>	F, S	Bird	(migrant) wetland
<b>Kendall</b>			
False spike, <i>Quadrula mitchelli</i>	S, Pe	Mussel	river
Golden orb, <i>Quadrula aurea</i>	S, C	Mussel	river
Texas fatmucket, <i>Lampsilis bracteata</i>	S, C	Mussel	river

Texas pimpleback, <i>Quadrula petrina</i>	S, C	Mussel	river
Cascade caverns salamander, <i>Eurycea latitans</i> complex	S, Pe	Amphibian	aquatic cave
Comal blind salamander, <i>Eurycea tridentifera</i>	S, Pe	Amphibian	aquatic cave, spring
Texas salamander, <i>Eurycea neotenes</i>	Pe	Amphibian	aquatic cave, spring
Cagle's map turtle, <i>Graptemys caglei</i>	S	Reptile	freshwater
Spot-tailed earless lizard, <i>Holbrookia lacerata</i>	Pe	Reptile	desert, grassland, shrubland, oak-juniper woodlands
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines
Bald eagle, <i>Haliaeetus leucocephalus</i>	S	Bird	(migrant/winter) woodland, riparian, open water
Red Knot, <i>Calidris canutus</i> ssp. <i>rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh
Whooping crane, <i>Grus americana</i>	F, S	Bird	(migrant) wetland
Zone-tailed hawk, <i>Buteo albonotatus</i>	S	Bird	(breeding) arid scrub, pine-oak woodlands, cliffs/canyons
Big red sage, <i>Salvia penstemonoides</i>	Pe	Plant	stream banks, limestone ledges
<b>Kerr</b>			
False spike, <i>Quadrula mitchelli</i>	S, Pe	Mussel	river
Golden orb, <i>Quadrula aurea</i>	S, C	Mussel	river
Texas fatmucket, <i>Lampsilis bracteata</i>	S, C	Mussel	river
Texas pimpleback, <i>Quadrula petrina</i>	S, C	Mussel	river
Cascade caverns salamander, <i>Eurycea latitans</i> complex	S, Pe	Amphibian	aquatic cave
Cagle's map turtle, <i>Graptemys caglei</i>	S	Reptile	freshwater
Spot-tailed earless lizard, <i>Holbrookia lacerata</i>	Pe	Reptile	desert, grassland, shrubland, oak-juniper woodlands
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines
Bald eagle, <i>Haliaeetus leucocephalus</i>	S	Bird	(migrant/winter) woodland, riparian, open water
Red Knot, <i>Calidris canutus</i> ssp. <i>rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh
Zone-tailed hawk, <i>Buteo albonotatus</i>	S	Bird	(breeding) arid scrub, pine-oak woodlands, cliffs/canyons
Big red sage, <i>Salvia penstemonoides</i>	Pe	Plant	stream banks, limestone ledges
Tobusch fishhook cactus, <i>Sclerocactus brevihamatus</i> ssp. <i>tobuschii</i>	F, S	Plant	live oak-juniper shrublands
<b>Kimble</b>			
False spike, <i>Quadrula mitchelli</i>	S, Pe	Mussel	river
Smooth pimpleback, <i>Quadrula houstonensis</i>	S, C	Mussel	river
Texas fatmucket, <i>Lampsilis bracteata</i>	S, C	Mussel	river

Texas fawnsfoot, <i>Truncilla macrodon</i>	S, C	Mussel	river
Texas pimpleback, <i>Quadrula petrina</i>	S, C	Mussel	river
Spot-tailed earless lizard, <i>Holbrookia lacerata</i>	Pe	Reptile	desert, grassland, shrubland, oak-juniper woodlands
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines
Bald eagle, <i>Haliaeetus leucocephalus</i>	S	Bird	(migrant/winter) woodland, riparian, open water
Red Knot, <i>Calidris canutus ssp. rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh
Zone-tailed hawk, <i>Buteo albonotatus</i>	S	Bird	(breeding) arid scrub, pine-oak woodlands, cliffs/canyons
Tobusch fishhook cactus, <i>Sclerocactus brevihamatus ssp. tobuschii</i>	F, S	Plant	live oak-juniper shrublands
<b>Kinney</b>			
False spike, <i>Quadrula mitchelli</i>	S, Pe	Mussel	river
Mexican fawnsfoot, <i>Truncilla cognate</i> (Rio Grande River)	S, Pe	Mussel	river
Salina mucket, <i>Potamilus metnecktayi</i> (Rio Grande River)	S, Pe	Mussel	river
Blue sucker, <i>Cycleptus elongatus</i>	S	Fish	river
Chihuahua catfish, <i>Ictalurus sp 1</i> (Rio Grande River)	Pe	Fish	river
Devils River minnow, <i>Dionda diaboli</i> (Rio Grande River)	F, S	Fish	freshwater stream
Proserpine shiner, <i>Cyprinella proserpina</i>	S	Fish	freshwater stream
Rio Grande darter, <i>Etheostoma grahami</i>	S	Fish	freshwater stream
Reticulate collared lizard, <i>Crotaphytus reticulatus</i>	S, Pe	Reptile	shrubland
Spot-tailed earless lizard, <i>Holbrookia lacerata</i>	Pe	Reptile	desert, grassland, shrubland, oak-juniper woodlands
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland
Texas indigo snake, <i>Drymarchon melanurus erebennus</i>	S	Reptile	mesquite brush near water
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines
Texas tortoise, <i>Gopherus berlandieri</i>	S	Reptile	grassland, shrubland, woodland
Red Knot, <i>Calidris canutus ssp. rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh
Zone-tailed hawk, <i>Buteo albonotatus</i>	S	Bird	(breeding) arid scrub, pine-oak woodlands, cliffs/canyons
Correll's false dragon-head, <i>Physostegia correllii</i>	Pe	Plant	wetland/riparian
Texas snowbells, <i>Styrax platanifolius</i>	F, S	Plant	wooded limestone cliff

<i>ssp. texanus</i>			
Tobusch fishhook cactus, <i>Sclerocactus brevihamatus</i> ssp. <i>tobuschii</i>	F, S	Plant	live oak-juniper shrublands
<b>Lampasas</b>			
False spike, <i>Quadrula mitchelli</i>	S, Pe	Mussel	river
Smooth pimpleback, <i>Quadrula houstonensis</i>	S, C	Mussel	river
Texas fatmucket, <i>Lampsilis bracteata</i>	S, C	Mussel	river
Texas fawnsfoot, <i>Truncilla macrodon</i>	S, C	Mussel	river
Texas pimpleback, <i>Quadrula petrina</i>	S, C	Mussel	river
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines
Bald eagle, <i>Haliaeetus leucocephalus</i>	S	Bird	(migrant/winter) woodland, riparian, open water
Red Knot, <i>Calidris canutus</i> ssp. <i>rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh
Whooping crane, <i>Grus americana</i>	F, S	Bird	(migrant) wetland
<b>Llano</b>			
False spike, <i>Quadrula mitchelli</i>	S, Pe	Mussel	river
Smooth pimpleback, <i>Quadrula houstonensis</i>	S, C	Mussel	river
Texas fatmucket, <i>Lampsilis bracteata</i>	S, C	Mussel	river
Texas fawnsfoot, <i>Truncilla macrodon</i>	S, C	Mussel	river
Texas pimpleback, <i>Quadrula petrina</i>	S, C	Mussel	river
Spot-tailed earless lizard, <i>Holbrookia lacerata</i>	Pe	Reptile	desert, grassland, shrubland, oak-juniper woodlands
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines
Bald eagle, <i>Haliaeetus leucocephalus</i>	S	Bird	(migrant/winter) woodland, riparian, open water
Red Knot, <i>Calidris canutus</i> ssp. <i>rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh
Whooping crane, <i>Grus americana</i>	F, S	Bird	(migrant) wetland
Zone-tailed hawk, <i>Buteo albonotatus</i>	S	Bird	(breeding) arid scrub, pine-oak woodlands, cliffs/canyons
<b>Mason</b>			
False spike, <i>Quadrula mitchelli</i>	S, Pe	Mussel	river
Smooth pimpleback, <i>Quadrula houstonensis</i>	S, C	Mussel	river
Texas fatmucket, <i>Lampsilis bracteata</i>	S, C	Mussel	river
Texas fawnsfoot, <i>Truncilla macrodon</i>	S, C	Mussel	river
Texas pimpleback, <i>Quadrula petrina</i>	S, C	Mussel	river
Spot-tailed earless lizard, <i>Holbrookia lacerata</i>	Pe	Reptile	desert, grassland, shrubland, oak-juniper woodlands
Texas horned lizard, <i>Phrynosoma</i>	S	Reptile	desert, grassland, shrubland

<i>cornutum</i>			
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines
Bald eagle, <i>Haliaeetus leucocephalus</i>	S	Bird	(migrant/winter) woodland, riparian, open water
Red Knot, <i>Calidris canutus ssp. rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh
Whooping crane, <i>Grus americana</i>	F, S	Bird	(migrant) wetland
Zone-tailed hawk, <i>Buteo albonotatus</i>	S	Bird	(breeding) arid scrub, pine-oak woodlands, cliffs/canyons
<b>McLennan</b>			
False spike, <i>Quadrula mitchelli</i>	S, Pe	Mussel	river
Smooth pimpleback, <i>Quadrula houstonensis</i>	S, C	Mussel	river
Texas fawnsfoot, <i>Truncilla macrodon</i>	S, C	Mussel	river
Blue sucker, <i>Cycleptus elongatus</i>	S	Fish	river
Sharpnose Shiner, <i>Notropis oxyrhynchus</i>	C	Fish	river
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland
Timber/Canebrake rattlesnake, <i>Crotalus horridus</i>	S	Reptile	woodland, wetland
Western chicken turtle, <i>Deirochelys reticularia miaria</i>	Pe	Reptile	lakes, oxbows, swamps, marshes, ephemeral bodies of water
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines
Bald eagle, <i>Haliaeetus leucocephalus</i>	S	Bird	(migrant/winter) woodland, riparian, open water
Red Knot, <i>Calidris canutus ssp. rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh
Whooping crane, <i>Grus americana</i>	F, S	Bird	(migrant) wetland
Wood stork, <i>Mycteria americana</i>	F, S	Bird	(migrant) wetland, marsh
<b>Medina</b>			
False spike, <i>Quadrula mitchelli</i>	S, Pe	Mussel	river
Golden orb, <i>Quadrula aurea</i>	S, C	Mussel	river
Texas pimpleback, <i>Quadrula petrina</i>	S, C	Mussel	river
Blue sucker, <i>Cycleptus elongatus</i>	S	Fish	river
Spot-tailed earless lizard, <i>Holbrookia lacerata</i>	Pe	Reptile	desert, grassland, shrubland, oak-juniper woodlands
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland
Texas indigo snake, <i>Drymarchon melanurus erebennus</i>	S	Reptile	mesquite brush near water
Texas tortoise, <i>Gopherus berlandieri</i>	S	Reptile	grassland, shrubland, woodland
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines
Red Knot, <i>Calidris canutus ssp. rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh
Zone-tailed hawk, <i>Buteo albonotatus</i>	S	Bird	(breeding) arid scrub, pine-oak woodlands,

			cliffs/canyons
Bracted twistflower, <i>Streptanthus bracteatus</i>	C	Plant	woodland
<b>Menard</b>			
False spike, <i>Quadrula mitchelli</i>	S, Pe	Mussel	river
Smooth pimpleback, <i>Quadrula houstonensis</i>	S, C	Mussel	river
Texas fatmucket, <i>Lampsilis bracteata</i>	S, C	Mussel	river
Texas fawnsfoot, <i>Truncilla macrodon</i>	S, C	Mussel	river
Texas pimpleback, <i>Quadrula petrina</i>	S, C	Mussel	river
Clear Creek gambusia, <i>Gambusia heterochir</i>	F, S	Fish	freshwater stream
Spot-tailed earless lizard, <i>Holbrookia lacerata</i>	Pe	Reptile	desert, grassland, shrubland, oak-juniper woodlands
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines
Bald eagle, <i>Haliaeetus leucocephalus</i>	S	Bird	(migrant/winter) woodland, riparian, open water
Red Knot, <i>Calidris canutus ssp. rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh
Zone-tailed hawk, <i>Buteo albonotatus</i>	S	Bird	(breeding) arid scrub, pine-oak woodlands, cliffs/canyons
<b>Palo Pinto</b>			
Smooth pimpleback, <i>Quadrula houstonensis</i>	S, C	Mussel	river
Texas fawnsfoot, <i>Truncilla macrodon</i>	S, C	Mussel	river
Sharpnose Shiner, <i>Notropis oxyrhynchus</i>	C	Fish	river
Brazos water snake, <i>Nerodia harteri</i>	S	Reptile	freshwater
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines
Bald eagle, <i>Haliaeetus leucocephalus</i>	S	Bird	(migrant/winter) woodland, riparian, open water
Red Knot, <i>Calidris canutus ssp. rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh
Whooping crane, <i>Grus americana</i>	F, S	Bird	(migrant) wetland
<b>Real</b>			
Spot-tailed earless lizard, <i>Holbrookia lacerata</i>	Pe	Reptile	desert, grassland, shrubland, oak-juniper woodlands
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland
Texas indigo snake, <i>Drymarchon melanurus erebennus</i>	S	Reptile	mesquite brush near water
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines
Red Knot, <i>Calidris canutus ssp. rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats

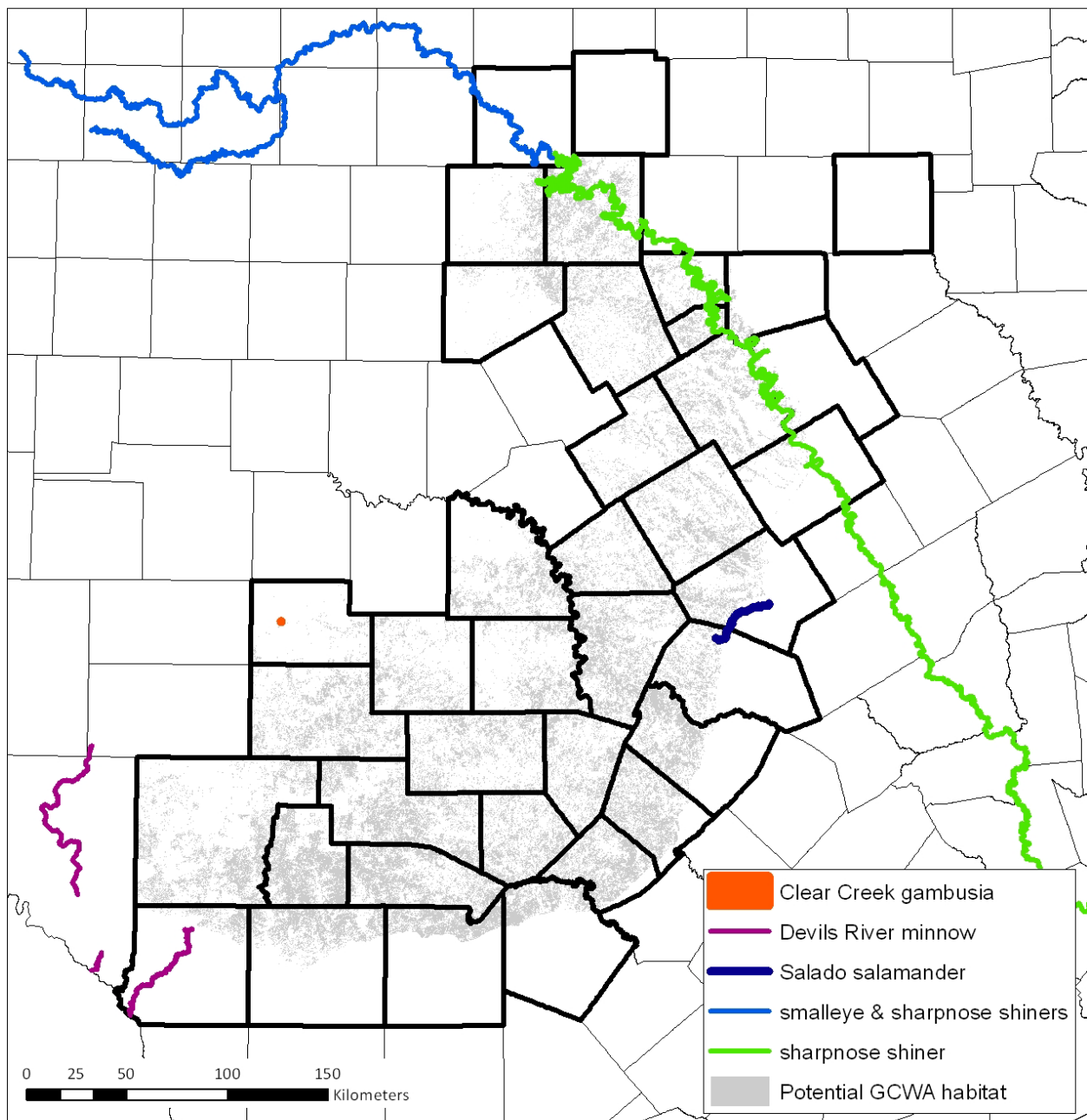
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh
Zone-tailed hawk, <i>Buteo albonotatus</i>	S	Bird	(breeding) arid scrub, pine-oak woodlands, cliffs/canyons
Big red sage, <i>Salvia penstemonoides</i>	Pe	Plant	stream banks, limestone ledges
Bracted twistflower, <i>Streptanthus bracteatus</i>	C	Plant	woodland
Texas snowbells, <i>Styrax platanifolius</i> ssp. <i>texanus</i>	F, S	Plant	wooded limestone cliff
Tobusch fishhook cactus, <i>Sclerocactus brevihamatus</i> ssp. <i>tobuschii</i>	F, S	Plant	live oak-juniper shrublands
<b>San Saba</b>			
False spike, <i>Quadrula mitchelli</i>	S, Pe	Mussel	river
Smooth pimpleback, <i>Quadrula houstonensis</i>	S, C	Mussel	river
Texas fatmucket, <i>Lampsilis bracteata</i>	S, C	Mussel	river
Texas fawnsfoot, <i>Truncilla macrodon</i>	S, C	Mussel	river
Texas pimpleback, <i>Quadrula petrina</i>	S, C	Mussel	river
Spot-tailed earless lizard, <i>Holbrookia lacerata</i>	Pe	Reptile	desert, grassland, shrubland, oak-juniper woodlands
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines
Bald eagle, <i>Haliaeetus leucocephalus</i>	S	Bird	(migrant/winter) woodland, riparian, open water
Red Knot, <i>Calidris canutus</i> ssp. <i>rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh
Whooping crane, <i>Grus americana</i>	F, S	Bird	(migrant) wetland
Zone-tailed hawk, <i>Buteo albonotatus</i>	S	Bird	(breeding) arid scrub, pine-oak woodlands, cliffs/canyons
<b>Somervell</b>			
False spike, <i>Quadrula mitchelli</i>	S, Pe	Mussel	river
Smooth pimpleback, <i>Quadrula houstonensis</i>	S, C	Mussel	river
Texas fawnsfoot, <i>Truncilla macrodon</i>	S, C	Mussel	river
Sharpnose Shiner, <i>Notropis oxyrhynchus</i>	C	Fish	river
Brazos water snake, <i>Nerodia harteri</i>	S	Reptile	freshwater
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland
Timber/Canebrake rattlesnake, <i>Crotalus horridus</i>	S	Reptile	woodland, wetland
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines
Bald eagle, <i>Haliaeetus leucocephalus</i>	S	Bird	(migrant/winter) woodland, riparian, open water
Red Knot, <i>Calidris canutus</i> ssp. <i>rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh



Whooping crane, <i>Grus americana</i>	F, S	Bird	(migrant) wetland
<b>Stephens</b>			
Smooth pimpleback, <i>Quadrula houstonensis</i>	S, C	Mussel	river
Texas fawnsfoot, <i>Truncilla macrodon</i>	S, C	Mussel	river
Brazos water snake, <i>Nerodia harteri</i>	S	Reptile	freshwater
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines
Bald eagle, <i>Haliaeetus leucocephalus</i>	S	Bird	(migrant/winter) woodland, riparian, open water
Red Knot, <i>Calidris canutus ssp. rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh
Whooping crane, <i>Grus americana</i>	F, S	Bird	(migrant) wetland
<b>Uvalde</b>			
Reticulate collared lizard, <i>Crotaphytus reticulatus</i>	S, Pe	Reptile	shrubland
Spot-tailed earless lizard, <i>Holbrookia lacerata</i>	Pe	Reptile	desert, grassland, shrubland, oak-juniper woodlands
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland
Texas indigo snake, <i>Drymarchon melanurus erebennus</i>	S	Reptile	mesquite brush near water
Texas tortoise, <i>Gopherus berlandieri</i>	S	Reptile	grassland, shrubland, woodland
American peregrine falcon, <i>Falco peregrinus anatum</i>	S	Bird	(migrant) open habitat, lake shores, coastlines
Red Knot, <i>Calidris canutus ssp. rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh
Zone-tailed hawk, <i>Buteo albonotatus</i>	S	Bird	(breeding) arid scrub, pine-oak woodlands, cliffs/canyons
Big red sage, <i>Salvia penstemonoides</i>	Pe	Plant	stream banks, limestone ledges
Bracted twistflower, <i>Streptanthus bracteatus</i>	C	Plant	woodland
Hall's pocket moss, <i>Fissidens hallii</i>	Pe	Plant	moist areas, swamps
Tobusch fishhook cactus, <i>Sclerocactus brevihamatus ssp. tobuschii</i>	F, S	Plant	live oak-juniper shrublands
<b>Young</b>			
Smooth pimpleback, <i>Quadrula houstonensis</i>	S, C	Mussel	river
Texas fawnsfoot, <i>Truncilla macrodon</i>	S, C	Mussel	river
Sharpnose Shiner, <i>Notropis oxyrhynchus</i>	C	Fish	river
Smalleye Shiner, <i>Notropis buccula</i>	C	Fish	river
Brazos water snake, <i>Nerodia harteri</i>	S	Reptile	freshwater
Texas horned lizard, <i>Phrynosoma cornutum</i>	S	Reptile	desert, grassland, shrubland
American peregrine falcon, <i>Falco</i>	S	Bird	(migrant) open habitat, lake shores, coastlines

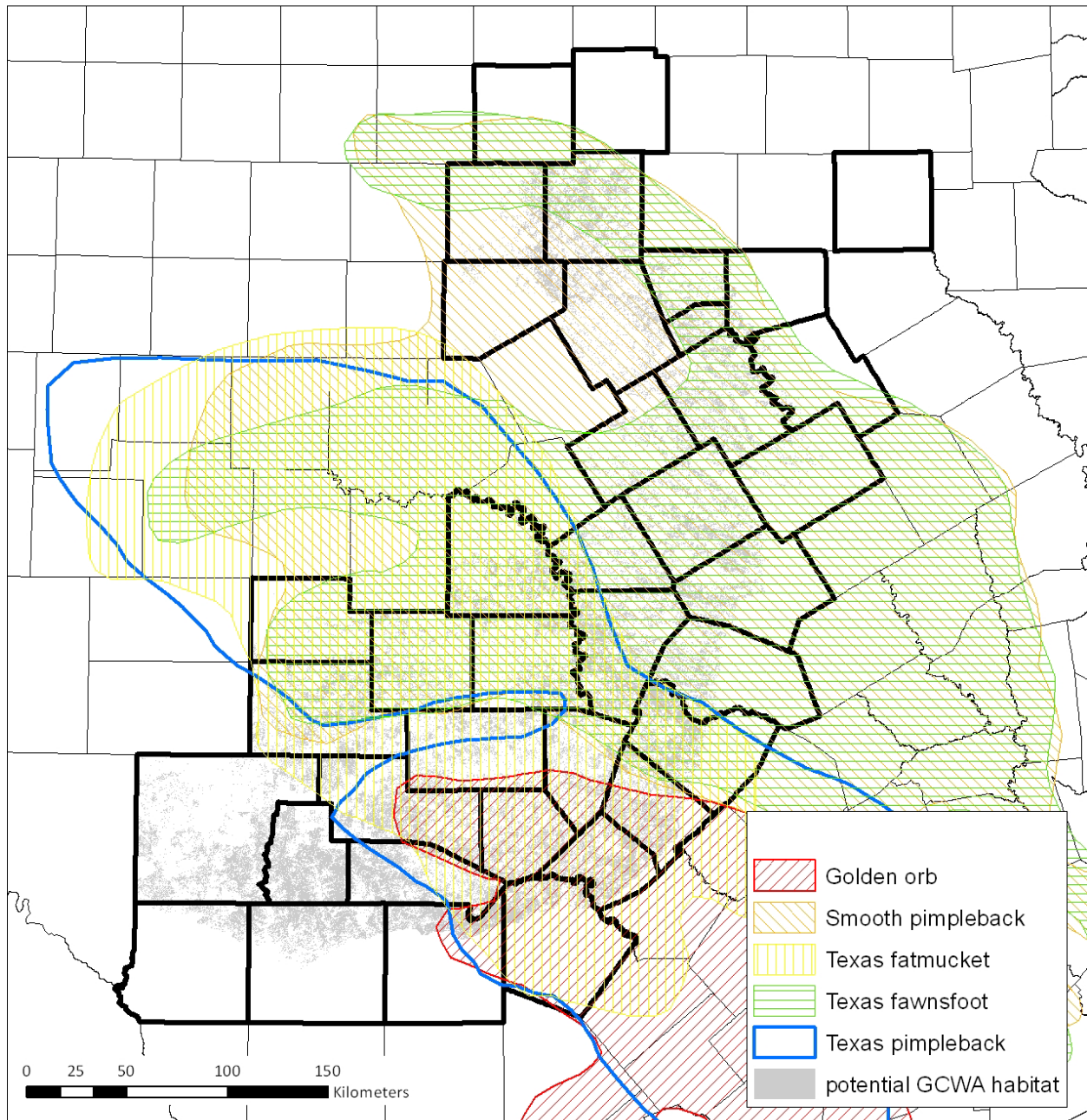


<i>peregrinus anatum</i>			
Bald eagle, <i>Haliaeetus leucocephalus</i>	S	Bird	(migrant/winter) woodland, riparian, open water
Red Knot, <i>Calidris canutus ssp. rufa</i>	C	Bird	(migrant) sandy beaches, tidal flats
Sprague's Pipit, <i>Anthus spragueii</i>	C	Bird	(winter) grassland
White-faced ibis, <i>Plegadis chihi</i>	S	Bird	(migrant) wetland, marsh
Whooping crane, <i>Grus americana</i>	F, S	Bird	(migrant) wetland
Texas kangaroo rat, <i>Dipodomys elator</i>	S, Pe	Mammal	arid areas with short, sparse grasses and little woody canopy cover



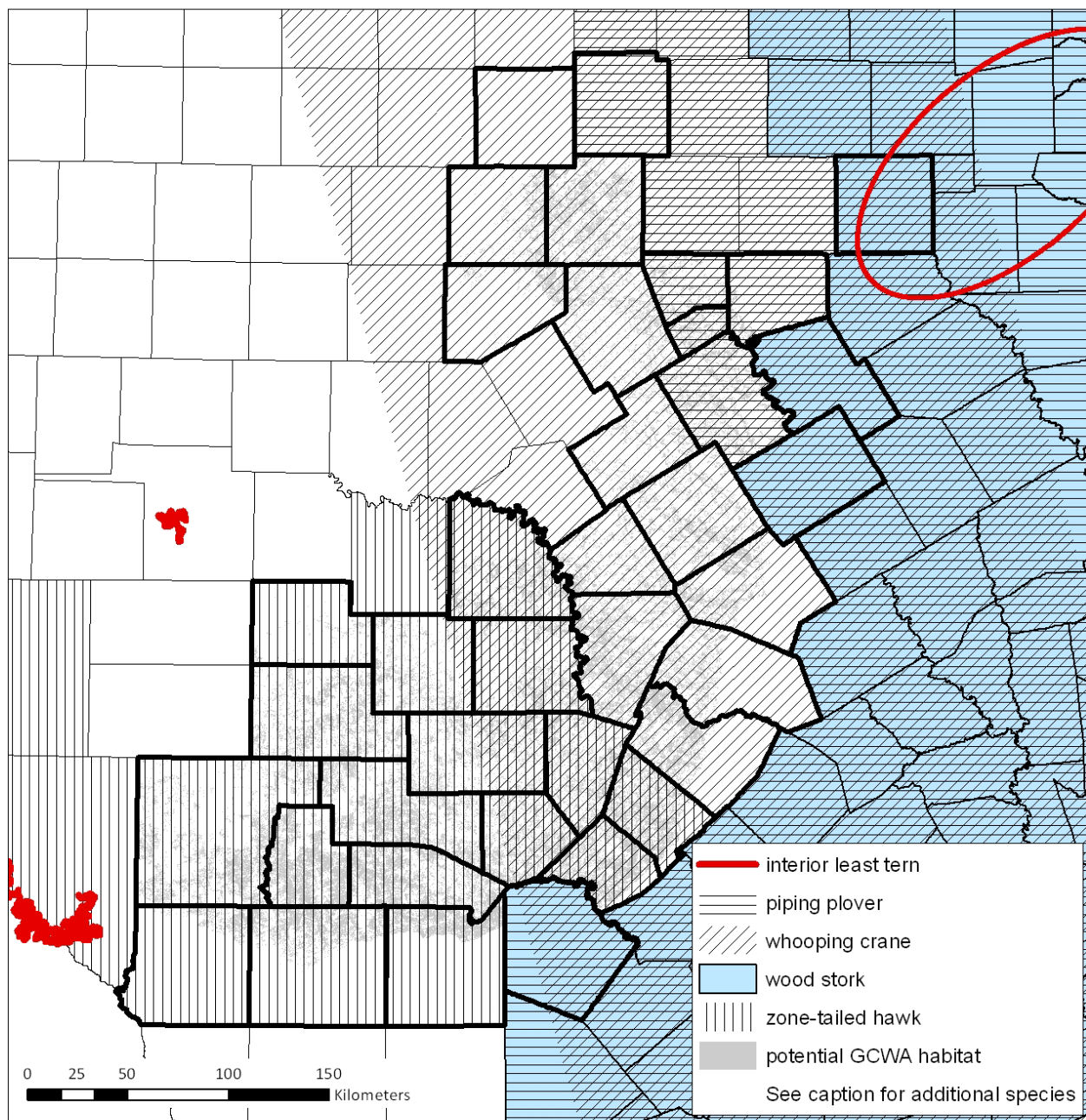
**Figure A.1.**

Approximate known or potential distributions of fish and amphibians listed in Table A.1. Potential golden-cheeked warbler habitat is included for context.



**Figure A.2.**

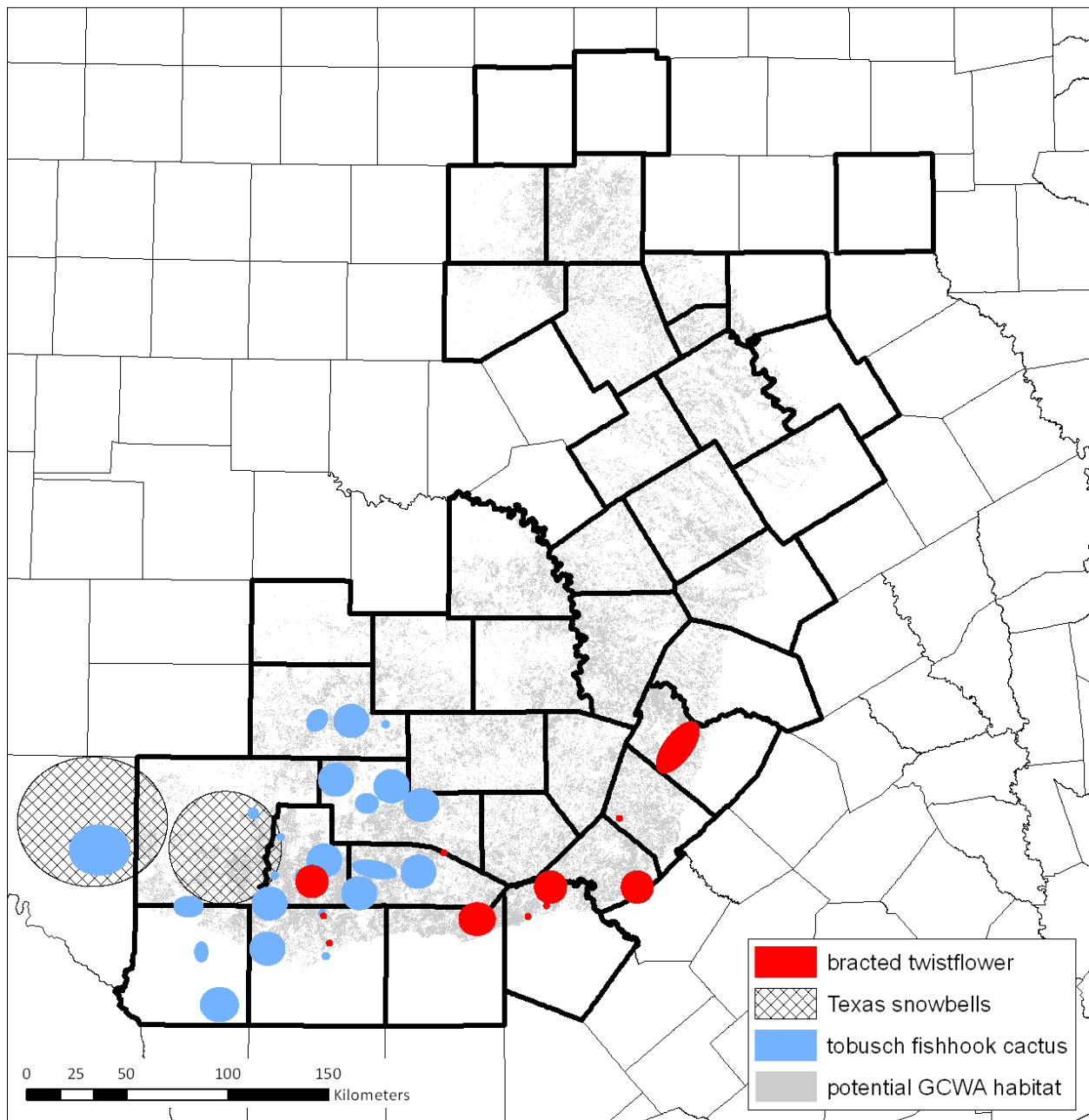
Approximate known or potential distributions of mussel species listed in Table A.1. Potential golden-cheeked warbler habitat is included for context.



**Figure A.3.**

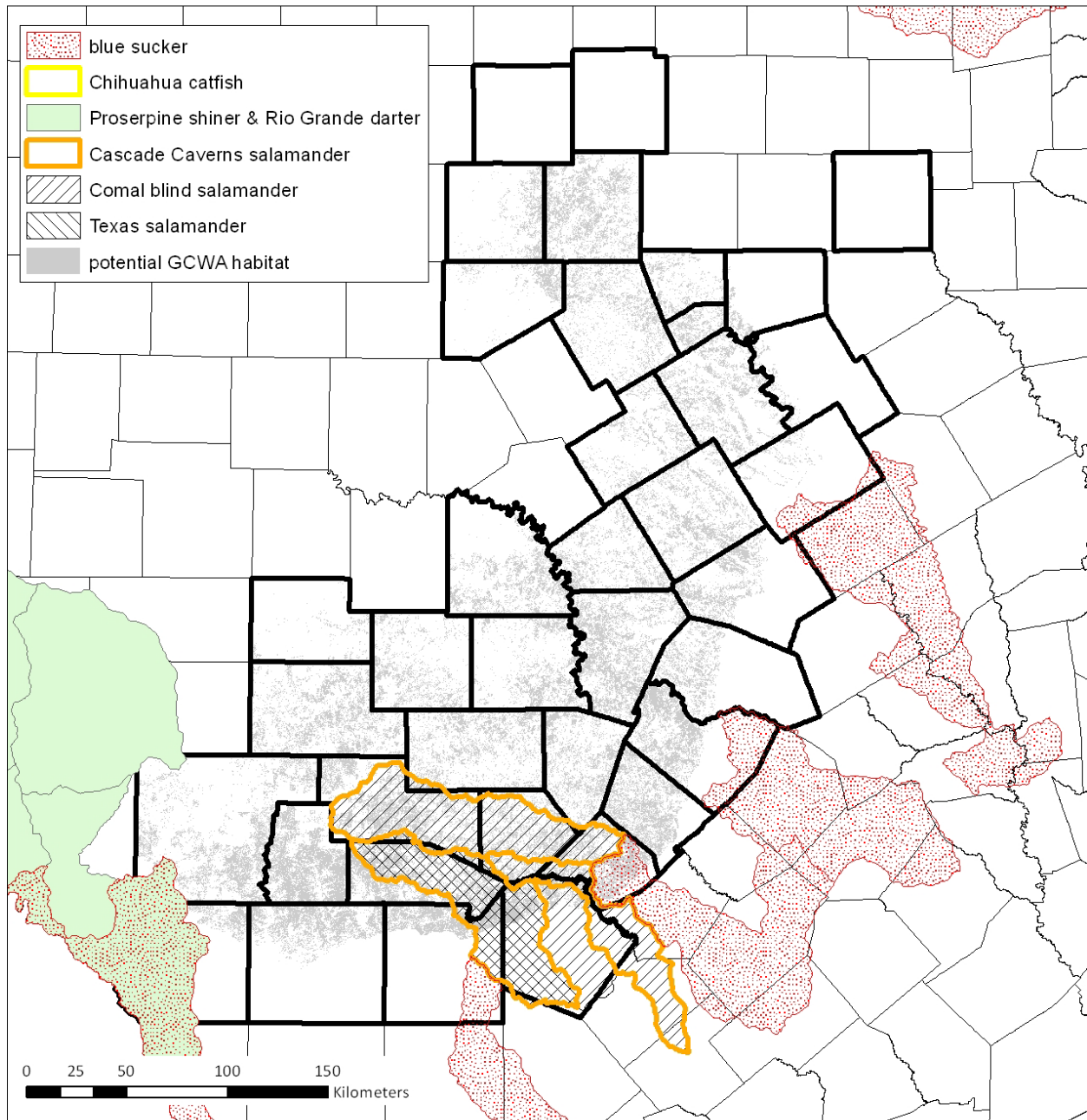
Approximate known or potential distributions of bird species listed in Tables A.1 and A.2. American peregrine falcon, red knot, Sprague's pipit, and white-faced ibis may occur throughout the Plan Area. Bald eagles may occur through the Plan Area except Bandera, Bexar, Edwards, Kinney, Medina, Real, and Uvalde. Potential golden-cheeked warbler habitat is included for context.





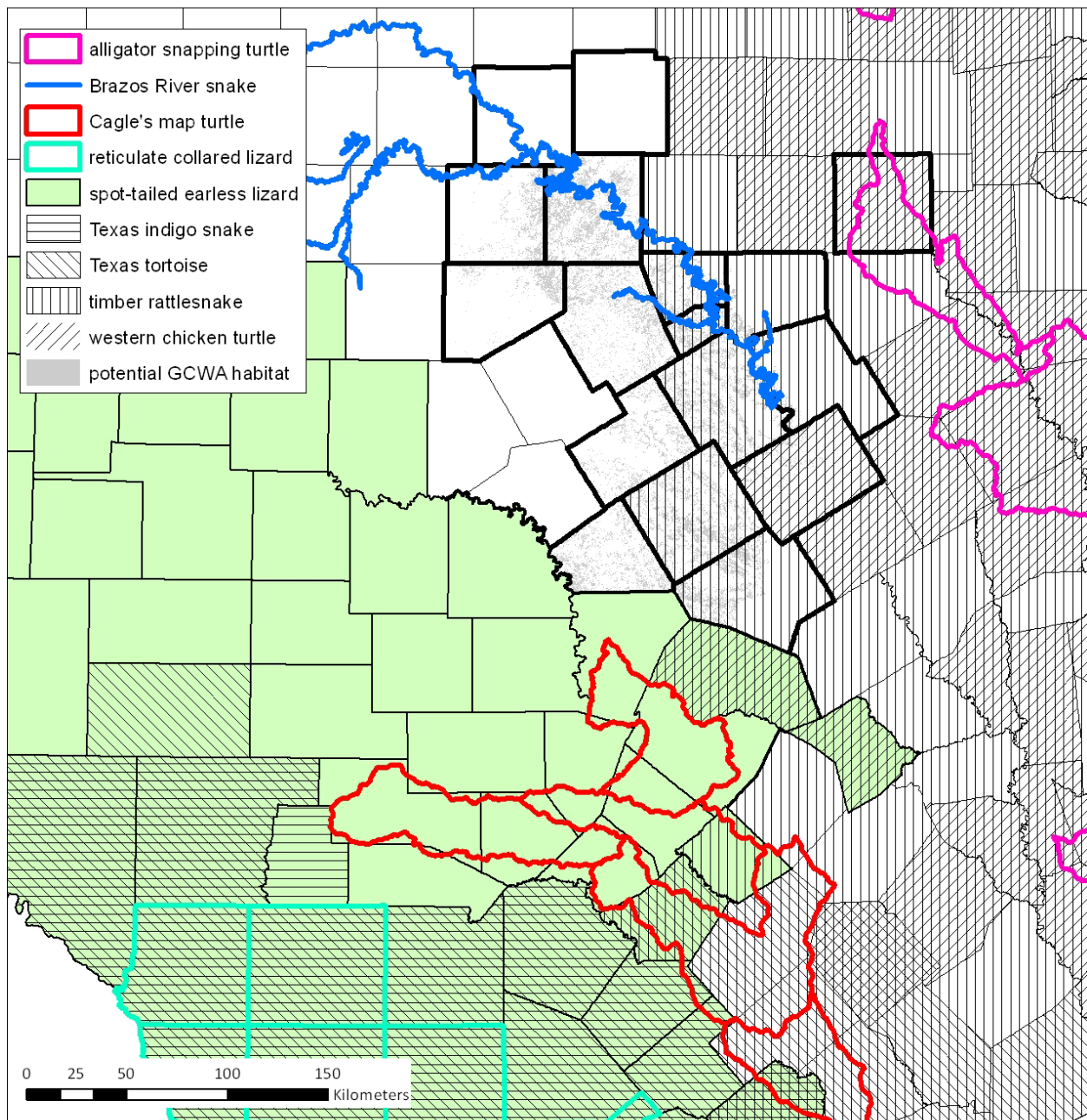
**Figure A.4.**

Approximate known or potential distributions of plant species listed in Table A.1. Potential golden-cheeked warbler habitat is included for context.



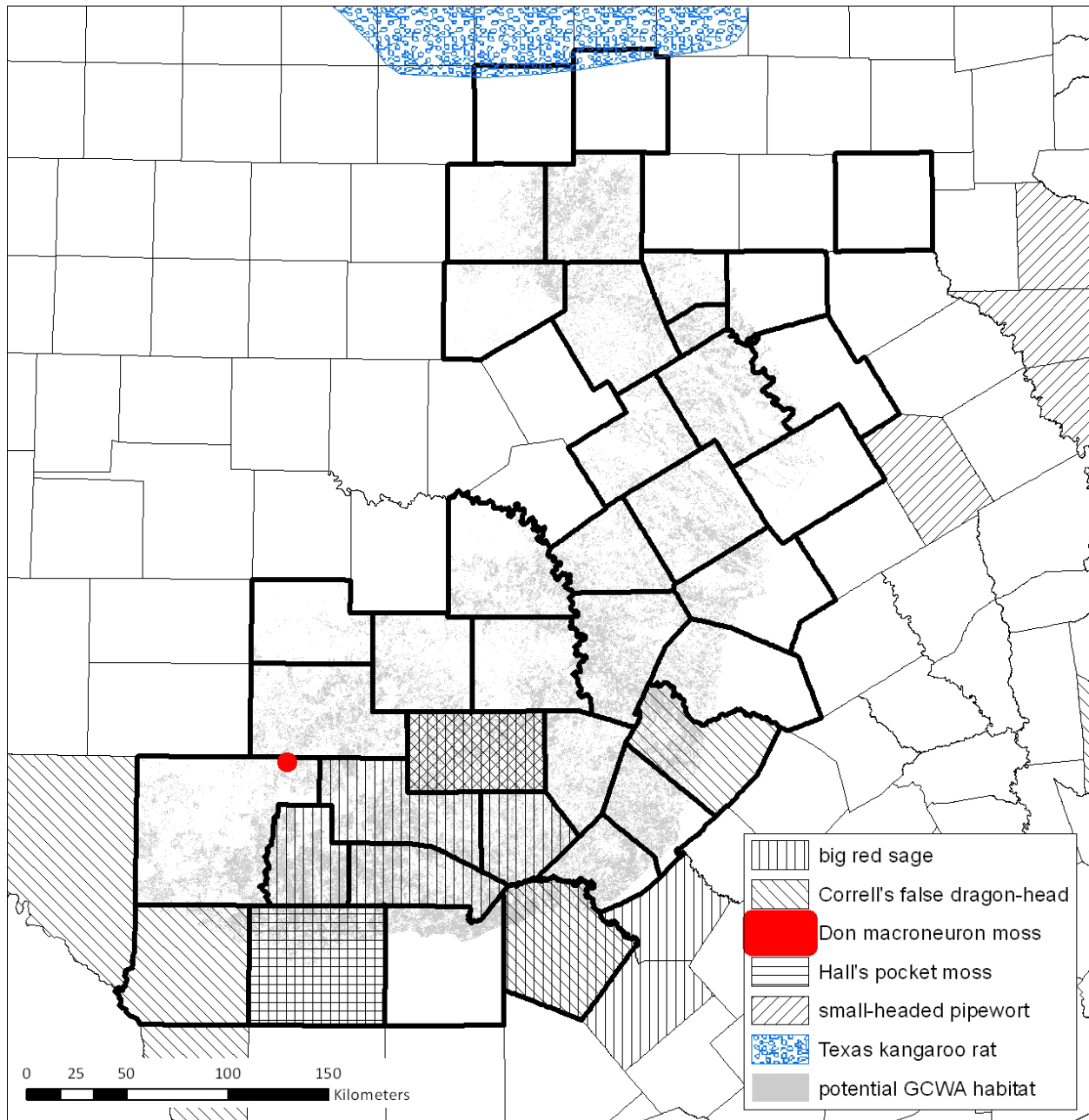
**Figure A.5.**

Approximate known or potential distributions of fish and amphibian species listed in Table A.2. Potential golden-cheeked warbler habitat is included for context.



**Figure A.6.**

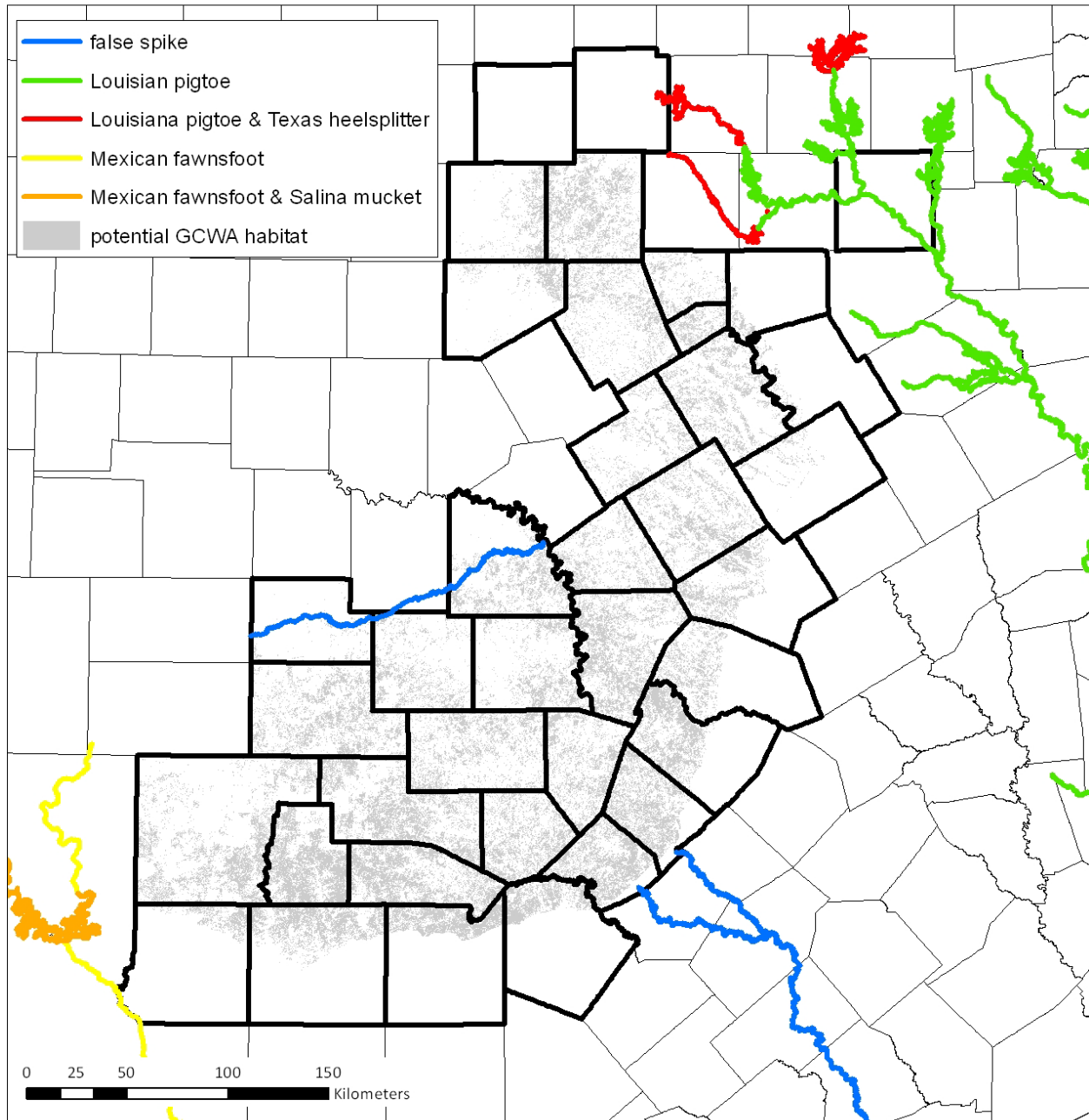
Approximate known or potential distributions of reptile species listed in Table A.2. The Texas horned lizard occurs throughout Texas. Potential golden-cheeked warbler habitat is included for context.



**Figure A.7.**

Approximate known or potential distributions of plant and mammal species listed in Table A.2. Potential golden-cheeked warbler habitat is included for context.





**Figure A.8.**

Approximate known or potential distributions of mussel species listed in Table A.2. There are only 2-3 current known locations for false spike. Potential golden-cheeked warbler habitat is included for context.

## Appendix B.

Number of black-capped vireos detected during in-field surveys, 2000 to 2010, by property, county, and BCVI recovery region. Includes updates to Wilkins et al. 2006 based on Texas A&M statewide surveys.

County	Wilkins et al. 2006		TAMU and other (post-2006)		Total # detected
	Number detected	Property	Number detected	Property	
<b><u>Recovery region 1</u></b>					
Callahan	2	TNDD			2
Comanche					0
Dallas*	1	Cedar Ridge Preserve			1
Erath*	16	TNDD			16
Hood*					0
Johnson*					0
Montague	2	private lands			2
Palo Pinto*	1	TNDD			1
Parker					0
Stephens*					0
<b><u>Recovery region 2</u></b>					
Bell*	1847	Fort Hood (Bell/Coryell border)	6	3 Parrie Haynes, 3 private	1853
Bosque*	1	road	6	private lands	7
Brown			1	Camp Bowie (TNDD)	1
Burnet*	88	57 BCNWR, 23 LCRA, 8 private	105	100 private, 5 Inks Lake SP	193
Coleman	6	road	5	private lands	11
Coryell*	67	private lands	217	187 Fort Hood, 30 private	284
Hamilton*	4	private lands			4
Lampasas*					0
Mills			7	private lands	7
Somervell*	20	3 Fossil Rim, 17 private	6	4 Quail Ridge, 2 Dinosaur Valley SP	26
Travis*	12	12 BCP, (BCNWR replaced)	69	33 BCNWR, 6 private	81
Williamson*	14	BCNWR	3	private lands	17
<b><u>Recovery region 3</u></b>					
Bandera*	28	10 Love Creek (TNC), 7 Hill Country SNA, 11 private	5	3 Lost Maples SP, 2 private	33
Bexar*	45	13 Bullis, 32 COSA	1	private lands	46
Blanco*	14	TNDD			14
Comal*					0
Edwards*	211	76 Dobbs properties, 135 road	429	40 Devils Sinkhole, 15 Kickapoo SP, 374 private	640
Gillespie*			2	private lands	2
Hays*			1	TNDD	1
Kendall*			3	private lands	3
Kerr*	436	358 Kerr WMA, 78 private	401	399 private, 2 Heart of the Hills SFH	837
Kimble*	35	Walter Buck WMA	12	private lands	47

Kinney*	54	52 Kickapoo SP (Kinney/Edwards border), 2 road	35	private lands	89
Llano*					0
Mason*	77	Mason Mtn WMA			77
McCulloch	1	road	3	private lands	4
Medina*	4	TNDD			4
Menard*	8	TNDD			8
Real*	93	private lands	18	private lands	111
San Saba*	11	Colorado Bend SP			11
Schleicher			1	private lands	1
Sutton	1	road	5	private lands	6
Uvalde*			2	private lands	2
<b><u>Recovery region 4</u></b>					
Coke	12	roads	1	TNDD	13
Concho	1	TNDD			1
Irion					0
Nolan	3	private lands			3
Runnels	2	roads			2
Sterling					0
Taylor	125	60 Horse Hollow, 59 Buffalo Gap Wind Farm, 6 Camp Barkeley	23	private lands	148
Tom Green	6	roads			6
<b><u>Recovery region 5</u></b>					
Crockett	2	roads	8	private lands	10
Terrell	86	60 Oasis & Canon ranches, 26 Independence Creek (TNC)			86
Val Verde	55	55 Dolan Falls, (Devils River SNA replaced)	476	341 Devils River SNA, 107 TNC, 28 private	531
<b><u>Recovery region 6</u></b>					
Brewster	15	Big Bend NP	1	private lands (~15 from TAMU 2009 Big Bend surveys)	16
Pecos			1	private lands	1
Total # BCVI in Texas	3406		1853		5259
Total # BCVI in CTGCP Plan Area	3087		1321		4408

## Appendix C.

Summary of research findings related to human impacts on GCWA or its habitat.

Results & conclusions relating to impacts (Y= found effect; N= found no effect; ?= inconclusive, due to study limitations, etc.)									
Citation	Patch size	Patch shape	Patch edge	Fragmentation	Urbanization	Noise	Other human activity or disturbance	Other impacts	Notes
<b>Peer-reviewed literature</b>									
Kroll 1980			? N						Didn't explicitly test any hypotheses, just descriptive
Demoll et al. 1984					? N	? N	? N		Didn't explicitly test any hypotheses, just breeding bird census done near human development
Engels & Sexton 1994			?		?			GCWA negatively correlated with BLJA	They inferred this correlation implies major impact of BLJA on GCWA due to urbanization
Benson 1995						N			
Anders & Dearborn 2004			? N	? N		? N	? N		Didn't explicitly test any hypotheses, correlations based on point count locations on FH in relation to military training and burned areas.
Magness et al. 2006			N	N					
Peak 2007			Y						Fort Hood only
Reidy et al 2008	?				N				Concluded that GCWA can nest successfully in urban and rural but says patch size is important, though this project wasn't designed to study that.
Reidy et al. 2009			? Y		N				Nest initiation date and edge density had greatest effect on nest success. Concludes that large blocks of habitat are needed but also must be protected from fragmentation.
Sperry et al. 2009			?						Found snakes use edges more than random; GCWA nest success negatively correlated with increasing nest height. This was interpreted as higher nests being closer to an "edge" as in the top of the canopy
Butcher et al. 2010	Y								Designed study to explicitly test patch size hypotheses; found threshold size for pairing and

									fledging.
Davis et al. 2010			? Y	? Y		? Y	? Y (mountain biking)		2 pairs of sites (1 on/around Fort Hood, other in Travis Cty)
Lackey et al. 2012						N	N (road construction)		No effect of construction noise on density or reproductive success over 3 years of sampling at 3 sites in Real and Uvalde counties.
<b>Theses, dissertations, or reports</b>									
Benson 1990	? N	? N	? N		? N				
Arnold et al. 1996	Y *		?		?				* same dataset as Coldren
Coldren 1998	Y	<i>same as size</i>	?	N	?				Sites were only in Travis county. Observed apparent edge effects were statistically tied to patch size (as illustrated). Some of this is difficult to interpret because of substantial data transformation, categorization, and other procedures whose purpose and acceptability are not clear. And several results are confounded by design problems.
Peak 2003							? N mountain biking		Did not detect a difference in GCWA abundance or demography between BLORA mountain bike park and non-bike study area, but inference is limited; similar dataset as Davis et al. 2010
Johnston 2006					?		? (pets)		Looked at potential predator (birds and mammals) use of different edge types in 3 adjacent tracts in Travis County, but not actual predation on GCWA; noted concern about outdoor pets
Sperry 2007			?		? Y	?	?	?	Impact assessment approach (not replicated, so no inference outside of this 1 place). I can't fully follow her metrics especially for GCWA. Also looked at predators and microclimate variables, but not well connected with warbler responses.

Anders, A. D., and D. C. Dearborn. 2004. Population trends of the endangered golden-cheeked warbler at Fort Hood, Texas, from 1992–2001. The Southwestern Naturalist 49:39–47.

Arnold, K. A., C. L. Coldren, and M. L. Fink. 1996. The interactions between avian predators and golden-cheeked warblers in Travis County. Texas Transportation Institute. The Texas A&M University System, Texas Department of Transportation. Report 1983-2.

Benson, R. H. 1990. Habitat area requirements of the golden-cheeked warbler on the Edwards Plateau. Texas Parks and Wildlife Department, Austin, Texas, USA.

Benson, R. H. 1995. The effect of roadway traffic noise on territory selection by golden-cheeked warblers. Bulletin of the Texas Ornithological Society 28:42–51.

- Butcher, J. A., M. L. Morrison, D. Ransom, Jr., R. D. Slack, and R. N. Wilkins. 2010. Evidence of a minimum patch size threshold of reproductive success in an endangered songbird. *Journal of Wildlife Management* 74:133–139.
- Coldren, C. L. 1998. The effects of habitat fragmentation on the golden-cheeked warbler. Dissertation, Texas A&M University, College Station, Texas, USA.
- Davis, C. A, D. M Leslie, Jr., W. D. Walter, and A. E. Graber. 2010. Mountain biking trail use affects reproductive success of nesting golden-cheeked warblers. *The Wilson Journal of Ornithology* 122:465–474.
- Demoll, E. W., M. Eckhoff, and F. S. Webster. 1984. Breeding bird census: 144. Juniper-oak woods on limestone hills. *American Birds* 38:110.
- Engels, T. M., and C. W. Sexton. 1994. Negative correlation of blue jays and golden-cheeked warblers near an urbanizing area. *Conservation Biology* 8:286–290.
- Johnston, M. M. 2006. A survey for potential predators of the golden-cheeked warbler (*Dendroica chrysoparia*) in relation to different edges at the Balcones Canyonlands Preserve. Thesis, Texas State University, San Marcos, Texas, USA.
- Kroll, J.C. 1980. Habitat requirements of the golden-cheeked warbler: Management implications. *Journal of Range Management* 33:60–65.
- Lackey, M. A., M. L. Morrison, Z. G. Loman, N. Fisher, S. L. Farrell, B. A. Collier, R. N. Wilkins. 2012. Effects of road construction noise on the endangered golden-cheeked warbler. *Wildlife Society Bulletin* 35:15–19.
- Magness, D. R., R. N. Wilkins, and S. J. Hejl. 2006. Quantitative relationships among golden-cheeked warbler occurrence and landscape size, composition, and structure. *Wildlife Society Bulletin* 34:473–479.
- Peak, R. G. 2003. Monitoring the golden-cheeked warbler at Belton Lake Outdoor Recreation Area mountain bike park, 1998–2003. Chapter 7 in *Endangered species monitoring and management at Fort Hood, Texas: 2003 annual report*. The Nature Conservancy, Fort Hood Project, Fort Hood, Texas, USA.
- Peak, R. G. 2007. Forest edges negatively affect golden-cheeked warbler nest survival. *Condor* 109:628–637.
- Reidy, J. L., M. M. Stake, and F. R. Thompson, III. 2008. Golden-cheeked warbler nest mortality and predators in urban and rural landscapes. *Condor* 110:458–466.
- Reidy, J. L., F. R. Thompson, III., and R. G. Peak. 2009. Factors affecting golden-cheeked warbler nest survival in urban and rural landscapes. *Journal of Wildlife Management* 73:407–413.
- Sperry, C. 2007. Influences of borders on golden-cheeked warbler habitat in the Balcones Canyonlands Preserve, Travis County, Texas. Texas State University, San Marcos, Texas, USA.
- Sperry, J. H., D. A. Cimprich, R. G. Peak, and P. J. Weatherhead. 2009. Is nest predation on two endangered bird species higher in habitats preferred by snakes? *Ecoscience* 16:111–118.

## Appendix D.

Estimates of GCWA (Table 1) and BCVI (Table 2) habitat loss in the GCP permit area through 2050 based on U.S. EPA projections of impervious surface (USEPA 2009) and Texas A&M IRNR occupancy models for each species. BC and A2 model scenarios represent the average and maximum projections, respectively, of changes in land use and corresponding increases in housing and impervious surface.

Table 1. Golden-cheeked warbler estimates of habitat loss (ha) in the GCP permit area. Region 5 includes only Burnet County and Region 6 includes only Kendall County.

		EPA 2050 Impervious Surface									
GCWA		<5%		5-25%		25-50%		>50%		Total, >5%	
Recovery Region	Occupancy probability	BC	A2	BC	A2	BC	A2	BC	A2	BC	A2
1	<25%	49,209	49,232	678	654	8	8	0	0	686	662
	25-50%	25,552	25,552	261	261	0	0	0	0	261	261
	50-75%	26,977	26,977	17	17	0	0	0	0	17	17
	75-90%	10,929	10,929	0	0	0	0	0	0	0	0
	>90%	0	0	0	0	0	0	0	0	0	0
	Total	112,666	112,690	955	932	8	8	0	0	963	939
2	<25%	61,747	60,972	1,586	2,341	40	60	0	0	1,627	2,401
	25-50%	31,890	31,679	116	327	0	0	0	0	116	327
	50-75%	32,063	31,984	316	396	0	0	0	0	316	396
	75-90%	17,515	17,515	127	97	0	0	0	0	127	97
	>90%	4,022	4,022	0	31	0	0	0	0	0	31
	Total	147,237	146,172	2,146	3,191	40	60	0	0	2,187	3,252
3	<25%	46,813	46,467	2,586	2,927	268	274	2	2	2,857	3,203
	25-50%	26,095	25,797	1,187	1,522	145	108	0	0	1,332	1,630
	50-75%	35,145	34,768	1,535	1,902	0	10	0	0	1,535	1,912
	75-90%	31,180	30,518	1,235	1,879	3	21	0	0	1,238	1,899
	>90%	20,780	20,513	730	998	6	6	0	0	737	1,005
	Total	160,014	158,063	7,274	9,228	423	419	2	2	7,700	9,650
4	<25%	82,549	82,547	781	792	16	7	0	0	797	799
	25-50%	40,603	40,592	137	164	16	0	0	0	153	164
	50-75%	44,855	44,855	34	38	4	0	0	0	38	38
	75-90%	39,628	39,609	0	18	0	0	0	0	0	18
	>90%	33,323	33,323	0	0	0	0	0	0	0	0
	Total	240,958	240,926	952	1,013	36	7	0	0	988	1,020
5	<25%	18,506	18,259	1,033	1,295	23	8	0	0	1,056	1,303
	25-50%	13,751	13,643	584	758	6	6	0	0	590	764

	<b>50-75%</b>	20,123	19,934	148	737	2	2	0	0	150	738
	<b>75-90%</b>	22,017	22,235	24	113	0	0	0	0	24	113
	<b>&gt;90%</b>	14,562	14,271	357	647	0	0	0	0	357	647
	<b>Total</b>	88,959	88,342	2,146	3,551	30	15	0	0	2,176	3,566
<b>6</b>	<b>&lt;25%</b>	11,071	10,829	464	707	11	11	0	0	475	718
	<b>25-50%</b>	6,417	6,311	264	369	0	0	0	0	264	369
	<b>50-75%</b>	9,301	9,139	187	349	0	0	0	0	187	349
	<b>75-90%</b>	11,002	10,807	103	298	0	0	0	0	103	298
	<b>&gt;90%</b>	16,018	15,949	85	153	0	0	0	0	85	153
	<b>Total</b>	53,809	53,035	1,103	1,877	11	11	0	0	1,114	1,888
<b>7</b>	<b>&lt;25%</b>	22,165	22,158	208	214	5	5	0	0	213	220
	<b>25-50%</b>	21,961	21,956	106	134	24	0	0	0	130	134
	<b>50-75%</b>	29,795	29,811	197	180	7	7	0	0	204	187
	<b>75-90%</b>	37,537	37,446	257	348	0	0	0	0	257	348
	<b>&gt;90%</b>	168,754	168,757	529	526	5	5	0	0	534	531
	<b>Total</b>	280,212	280,129	1,297	1,404	41	17	0	0	1,339	1,421
<b>8</b>	<b>&lt;25%</b>	4,367	4,152	329	519	0	26	0	0	329	545
	<b>25-50%</b>	8,360	8,252	340	445	0	2	0	0	340	447
	<b>50-75%</b>	12,657	12,422	378	613	0	0	0	0	378	613
	<b>75-90%</b>	18,392	18,317	313	388	0	0	0	0	313	388
	<b>&gt;90%</b>	266,778	266,515	455	699	0	19	0	0	455	718
	<b>Total</b>	310,553	309,657	1,815	2,664	0	47	0	0	1,815	2,711
<b>GCP permit area</b>											
	<b>&lt;25%</b>	296,427	294,615	7,665	9,450	372	399	2	2	8,039	9,852
	<b>25-50%</b>	174,628	173,783	2,994	3,980	191	116	0	0	3,185	4,096
	<b>50-75%</b>	210,916	209,890	2,813	4,233	13	18	0	0	2,826	4,251
	<b>75-90%</b>	188,199	187,376	2,059	3,141	3	21	0	0	2,062	3,161
	<b>&gt;90%</b>	524,237	523,350	2,156	3,056	12	31	0	0	2,168	3,087
<b>Total, all occupancy</b>		1,394,406	1,389,013	17,688	23,859	590	584	2	2	18,281	24,446
<b>Total, &gt;25% occupancy</b>		1,097,979	1,094,399	10,023	14,410	219	185	0	0	10,241	14,595



Table 2. Black-capped vireo estimates of habitat loss (ha) in the GCP permit area. Values include all pixels with >10% predicted probability of BCVI occupancy (McFarland et al. 2012) and >25% predicted increase in impervious surface (USEPA 2009). **\*\*TO BE UPDATED\*\***

Recovery Region	County	Estimated potential habitat	Estimated loss	
			BC	A2
1	Dallas	4	0	4
	Eastland	19,526	5	5
	Erath	3,742	0	0
	Hill	228	0	0
	Hood	12,477	57	114
	Jack	11,957	0	0
	Johnson	184	0	0
	Palo Pinto	34,373	26	26
	Stephens	37,435	4	4
	Young	10,042	0	0
	Total	129,967	92	153
2	Bell	23,351	188	119
	Bosque	46,308	26	26
	Burnet	37,055	34	24
	Coryell	38,828	134	134
	Hamilton	17,616	0	0
	Lampasas	14,635	0	0
	McLennan	2,749	5	3
	Somervell	17,433	0	0
	Total	197,975	387	306
3	Bandera	139,007		
	Blanco	16,768	0	0
	Edwards	538,067	0	0
	Gillespie	112,202	0	0
	Kendall	66,162	0	0
	Kerr	186,991	49	49
	Kimble	310,181	0	0
	Kinney	337,800	0	0
	Llano	91,932	13	3
	Mason	171,356	0	0
	Medina	181,701	71	76
	Menard	229,163	88	0
	Real	157,123	0	0
	San Saba	118,335	0	5
	Uvalde	317,422	218	111
	Total	2,974,209	438	244
GCP permit area		3,302,152	917	703

## Appendix E.

Sources and examples for best management practices (BMP) related to activities covered under the CTGCP.

### General

TPWD Wildlife Habitat Assessment Program,

[http://www.tpwd.state.tx.us/huntwild/wild/wildlife\\_diversity/habitat\\_assessment/](http://www.tpwd.state.tx.us/huntwild/wild/wildlife_diversity/habitat_assessment/)

Texas Commission on Environmental Quality, <http://www.tceq.state.tx.us/>

Texas State Soil and Water Conservation Board, <https://www.tsswcb.texas.gov/>

Texas Water Development Board, <https://www.twdb.texas.gov/>

### Erosion and sediment controls

- [http://www.tceq.texas.gov/publications/rg/rg-348/rg-348.html/at\\_download/file](http://www.tceq.texas.gov/publications/rg/rg-348/rg-348.html/at_download/file) (Edwards Aquifer)
- <http://m.tceq.texas.gov/assets/public/permitting/assess/401cert/401tier1des.pdf> (for small projects that affect less than 1,500 linear feet of stream and/or 3 acres of water)

### Revegetation of disturbed landscapes

- [http://www.tpwd.state.tx.us/huntwild/wild/wildlife\\_diversity/habitat\\_assessment/media/tpwd\\_disturbed\\_landscapes.pdf](http://www.tpwd.state.tx.us/huntwild/wild/wildlife_diversity/habitat_assessment/media/tpwd_disturbed_landscapes.pdf)

### Nonpoint source pollution

- <http://www.tceq.texas.gov/waterquality/nonpoint-source/mgmt-plan/index.html#bmp-finder>
- TCEQ/TSSWCB chapter 8: <https://www.tsswcb.texas.gov/files/docs/admin/Sunset2009/21G-NPS%20MGMT%20Program.pdf>
- TSSWCB – <http://www.tsswcb.texas.gov/files/contentimages/bmp.pdf> (200mb file)

Edwards Aquifer rules – these apply specifically in the Edwards Aquifer recharge, transition, and contributing zones, which include portions of Medina, Bexar, Comal, Kinney, Uvalde, Hays, Travis and Williamson Counties, but are relevant throughout the CTGCP area

- [http://www.tceq.texas.gov/publications/rg/rg-348/rg-348.html/at\\_download/file](http://www.tceq.texas.gov/publications/rg/rg-348/rg-348.html/at_download/file)

### Oak wilt prevention

NRCS: [http://www.tx.nrcs.usda.gov/technical/docs/txforestrytechnote\\_tx2.pdf](http://www.tx.nrcs.usda.gov/technical/docs/txforestrytechnote_tx2.pdf)

TFS: [http://www.texasoakwilt.org/Professionals/ISATTFSOakwiltpruningofficial\\_v2.pdf](http://www.texasoakwilt.org/Professionals/ISATTFSOakwiltpruningofficial_v2.pdf)

### Construction

#### General construction

- E.g., <http://www.cityofdenton.com/index.aspx?page=1013> (for Denton, TX, but can apply anywhere)

#### Construction and clearing within riparian areas

- [http://www.tpwd.state.tx.us/huntwild/wild/wildlife\\_diversity/habitat\\_assessment/media/tpwd\\_riparian\\_areas.pdf](http://www.tpwd.state.tx.us/huntwild/wild/wildlife_diversity/habitat_assessment/media/tpwd_riparian_areas.pdf)

#### Post-construction

- E.g., <http://www.killeentexas.gov/files/20120724%20Chapter%2032%20Post%20Construction%20Storm%20Water%20Control.pdf> (for Killeen, but can apply anywhere)

#### Information about low impact development

- <http://water.epa.gov/polwaste/green/index.cfm>

## Appendix F.

Details for quantifying project-specific indirect impacts in GCWA habitat.

Recent studies model relationships between patch size, GCWA occupancy probabilities, and GCWA density estimates (# male/ha; Collier et al. 2012, Mathewson et al. 2012). These relationships are used to assess indirect impacts, by calculating the difference in estimated GCWA density when a project results in a reduction in patch size sufficient to shift down from one size category to another (Tables 1 and 2). The average density of warblers for each of 10 occupancy probability categories, and corresponding patch size categories, are derived from Mathewson et al. (2012; Table 1). The decrease in density (Table 2) is then converted to hectares (Table 3), equaling the amount of area needed to mitigate for the indirect impacts.

For example, the shaded cells in Table 2 show that, on average, if 60 ha of habitat are cleared from a patch that was originally 200 ha (with average density of 0.192 male/ha, Table 1), the resulting patch of 140 ha (with average density of 0.158 male/ha, Table 1) has a GCWA density 0.034 less than the density in the same 140 hectares area prior to the impact ( $0.192 - 0.158 = 0.034$ ). That is, the remaining 140 ha is unlikely to sustain as many GCWAs as when the 140 ha were part of the original 200-ha patch. We consider this to be an indirect impact to those remaining 140 hectares. Using the values in Table 2, we can calculate that the remaining 140-ha patch has had a change (loss) of an estimated  $140 \text{ ha} \times -0.034 \text{ males/ha} = -4.76 \text{ males}$ . Since we are using impacts to habitat area as a proxy for take of individual GCWAs (see section 1.1), we convert this estimated loss of birds to hectares based on how many hectares are needed to sustain (and offset) the number of birds removed from the area due to the indirect impacts. We use an average density of 0.23 males/ha (Mathewson et al. 2012) for the conversion. In our example, the project that resulted in a 200-ha patch being reduced to 140 ha would require an additional 21 ha of mitigation for the indirect impacts ( $4.76 \text{ males} \div 0.23 \text{ male/ha} = 20.7 \text{ ha} \approx 21 \text{ ha}$ ). This is the same value as multiplying the remaining patch size of 140 by the hectare multiplier in Table 3; i.e.,  $140 \text{ ha} \times 0.15 = 21 \text{ ha}$ .

Table 1. Range-wide average of occupancy probabilities by patch size (Collier et al. 2012) and estimated GCWA density (# male/ha, Mathewson et al. 2012), based on Texas A&M GCWA habitat map and Texas A&M GCWA occupancy model. Occupancy probability values are used to calculate direct impacts while GCWA density estimates are used, in part, to calculate indirect impacts.

Patch size (ha)	Occupancy probability			Mean GCWA density
	Average	Category	Value used to calculate direct impacts	
2-5	0.08	0.0-0.1	0.05	0.048
>5-10	0.15	0.1-0.2	0.15	0.060
>10-20	0.23	0.2-0.3	0.25	0.073
>20-40	0.35	0.3-0.4	0.35	0.089
>40-60	0.46	0.4-0.5	0.45	0.108
>60-100	0.54	0.5-0.6	0.55	0.131
>100-150	0.65	0.6-0.7	0.65	0.158
>150-300	0.74	0.7-0.8	0.75	0.192
>300-800	0.85	0.8-0.9	0.85	0.232
>800	0.94	0.9-1.0	0.95	0.284

Table 2. Estimated change in GCWA density in a patch of given size, based on mean density values in Table 1. Numbers in bold are categories of patch size in hectares; number in parentheses are occupancy probability category. Shaded cells correspond to examples in the text.

Predicted change in GCWA density (# male per ha)											
	To										
	Patch size	<b>&gt;800</b> (0.9-1.0)	<b>&gt;300-800</b> (0.8-0.9)	<b>&gt;150-300</b> (0.7-0.8)	<b>&gt;100-150</b> (0.6-0.7)	<b>&gt;60-100</b> (0.5-0.6)	<b>&gt;40-60</b> (0.4-0.5)	<b>&gt;20-40</b> (0.3-0.4)	<b>&gt;10-20</b> (0.2-0.3)	<b>&gt;5-10</b> (0.1-0.2)	<b>2-5</b> (0.0-0.1)
From	<b>&gt;800</b>	0	-0.052	-0.092	-0.126	-0.153	-0.176	-0.195	-0.211	-0.224	-0.236
	<b>&gt;300-800</b>	X	0	-0.04	-0.074	-0.101	-0.124	-0.143	-0.159	-0.172	-0.184
	<b>&gt;150-300</b>	X	X	0	-0.034	-0.061	-0.084	-0.103	-0.119	-0.132	-0.144
	<b>&gt;100-150</b>	X	X	X	0	-0.027	-0.05	-0.069	-0.085	-0.098	-0.11
	<b>&gt;60-100</b>	X	X	X	X	0	-0.022	-0.041	-0.057	-0.07	-0.082
	<b>&gt;40-60</b>	X	X	X	X	X	0	-0.019	-0.035	-0.048	-0.06
	<b>&gt;20-40</b>	X	X	X	X	X	X	0	-0.016	-0.029	-0.041
	<b>&gt;10-20</b>	X	X	X	X	X	X	X	0	-0.013	-0.025
	<b>&gt;5-10</b>	X	X	X	X	X	X	X	X	0	-0.012
	<b>2-5</b>	X	X	X	X	X	X	X	X	X	0

Table 3. Absolute values from Table 2 are divided by 0.23 (range-wide average density of GCWA males) and rounded to the nearest 0.01 for an indirect impact multiplier, which is used to estimate the number of hectares necessary to mitigate for the loss of GCWA. Numbers in bold are categories of patch size in hectares; number in parentheses are occupancy probability category. Shaded cells correspond to examples in the text. This is the same table as Table 5.2 in the main document.

Predicted change in GCWA density (# male per ha)											
	To										
	Patch size	<b>&gt;800</b> (0.9-1.0)	<b>&gt;300-800</b> (0.8-0.9)	<b>&gt;150-300</b> (0.7-0.8)	<b>&gt;100-150</b> (0.6-0.7)	<b>&gt;60-100</b> (0.5-0.6)	<b>&gt;40-60</b> (0.4-0.5)	<b>&gt;20-40</b> (0.3-0.4)	<b>&gt;10-20</b> (0.2-0.3)	<b>&gt;5-10</b> (0.1-0.2)	<b>2-5</b> (0.0-0.1)
From	<b>&gt;800</b>	0.00	0.23	0.40	0.55	0.67	0.77	0.85	0.92	0.97	1.03
	<b>&gt;300-800</b>	X	0.00	0.17	0.32	0.44	0.54	0.62	0.69	0.75	0.80
	<b>&gt;150-300</b>	X	X	0.00	0.15	0.27	0.37	0.45	0.52	0.57	0.63
	<b>&gt;100-150</b>	X	X	X	0.00	0.12	0.22	0.30	0.37	0.43	0.48
	<b>&gt;60-100</b>	X	X	X	X	0.00	0.10	0.18	0.25	0.30	0.36
	<b>&gt;40-60</b>	X	X	X	X	X	0.00	0.08	0.15	0.21	0.26
	<b>&gt;20-40</b>	X	X	X	X	X	X	0.00	0.07	0.13	0.18
	<b>&gt;10-20</b>	X	X	X	X	X	X	X	0.00	0.06	0.11
	<b>&gt;5-10</b>	X	X	X	X	X	X	X	X	0.00	0.05
	<b>2-5</b>	X	X	X	X	X	X	X	X	X	0.00



## Appendix G.

Aerial imagery of black-capped vireo habitat.



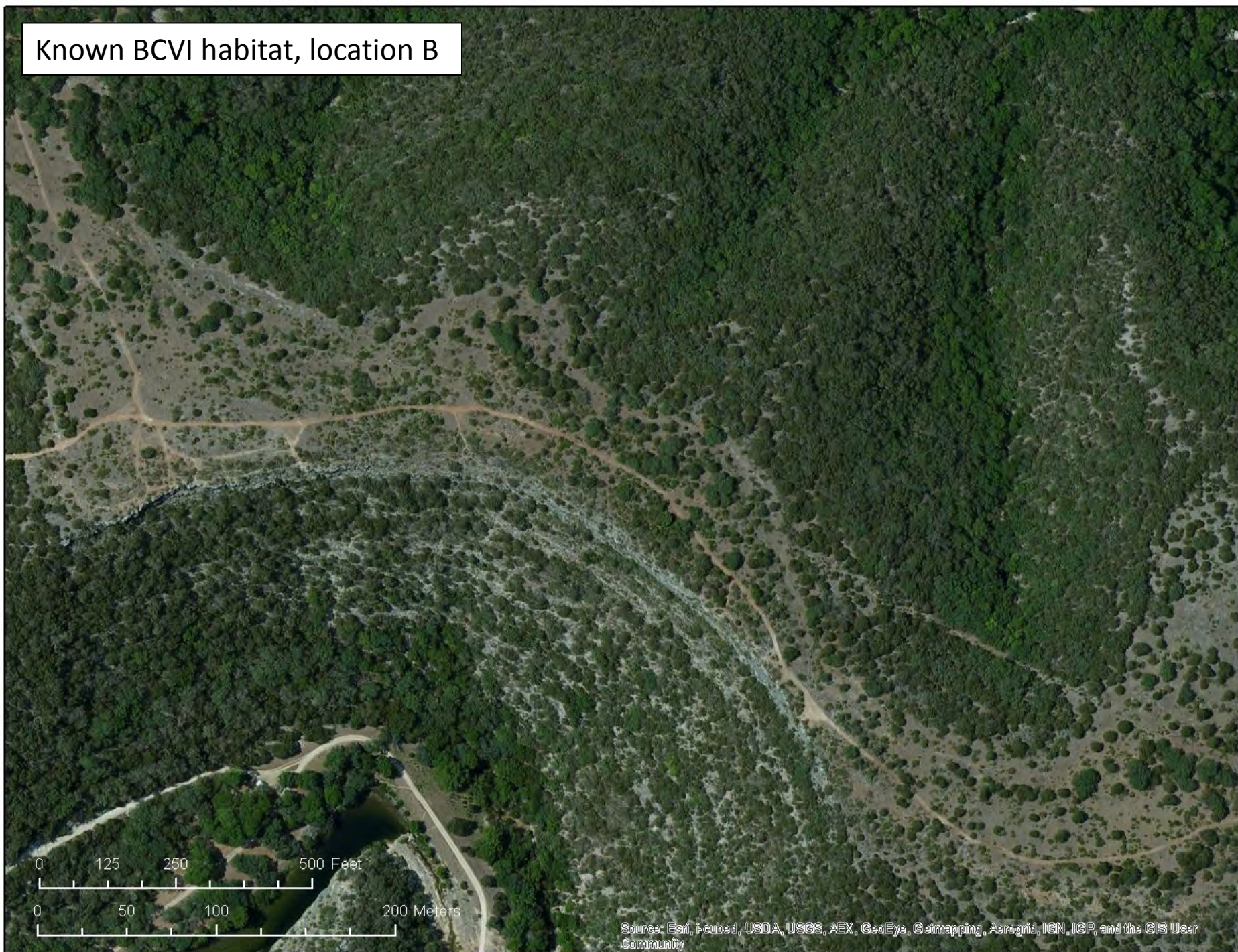


# Known BCVI habitat, location A





# Known BCVI habitat, location B



Source: Esri, DeLorme, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community



Known BCVI habitat, location B

0 250 500 1,000 Feet

0 100 200 400 Meters

Source: Esri, DeLorme, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community



# Known BCVI habitat, location C



Source: Esri, IntelSat, USDA, USGS, AEX, GeoEye, GeoWorld, IGN, IGP, and the GIS User Community



Known BCVI habitat, location C





Known BCVI habitat, location D



Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community



# Known BCVI habitat, location D



Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community



# Known BCVI habitat, location E



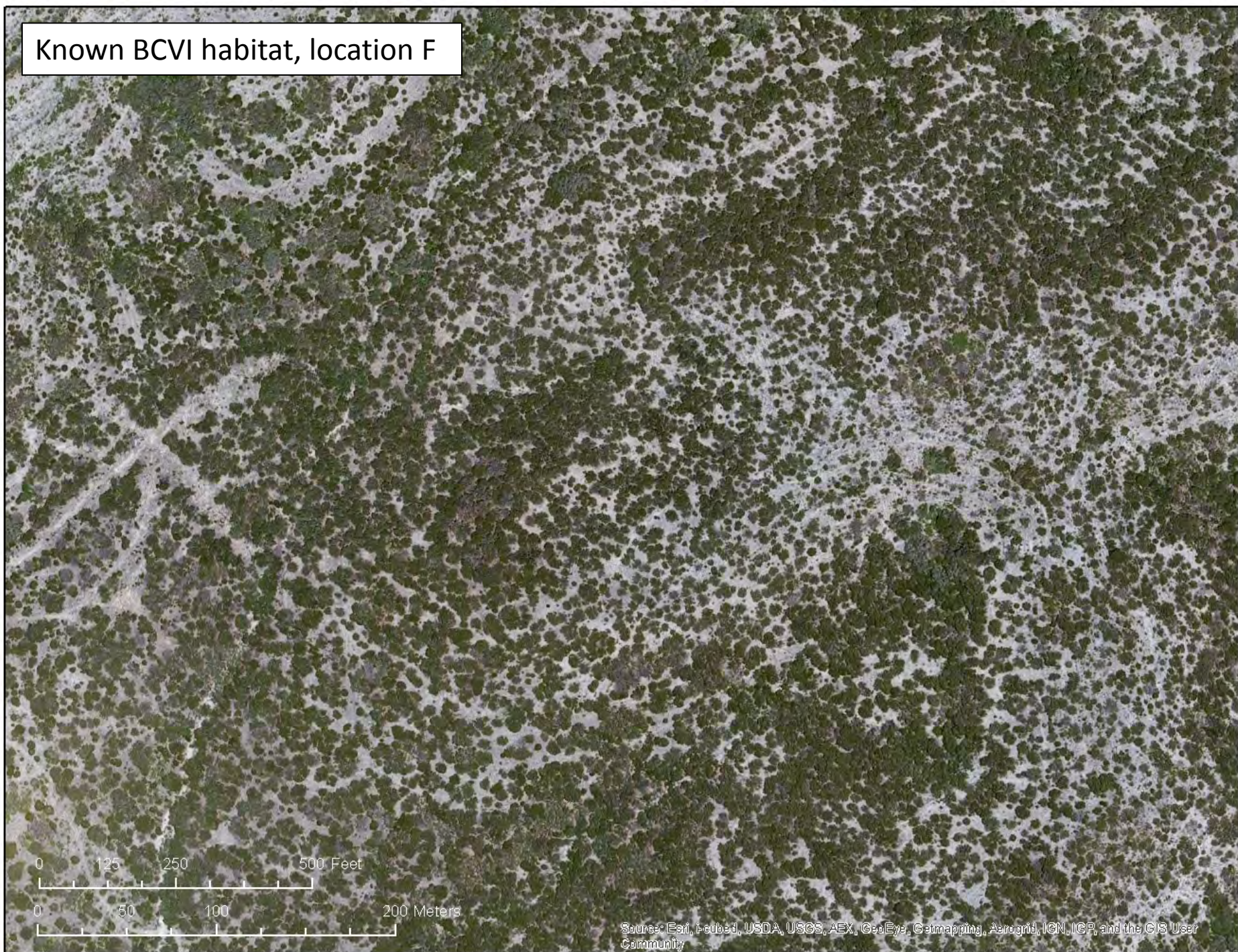


# Known BCVI habitat, location E



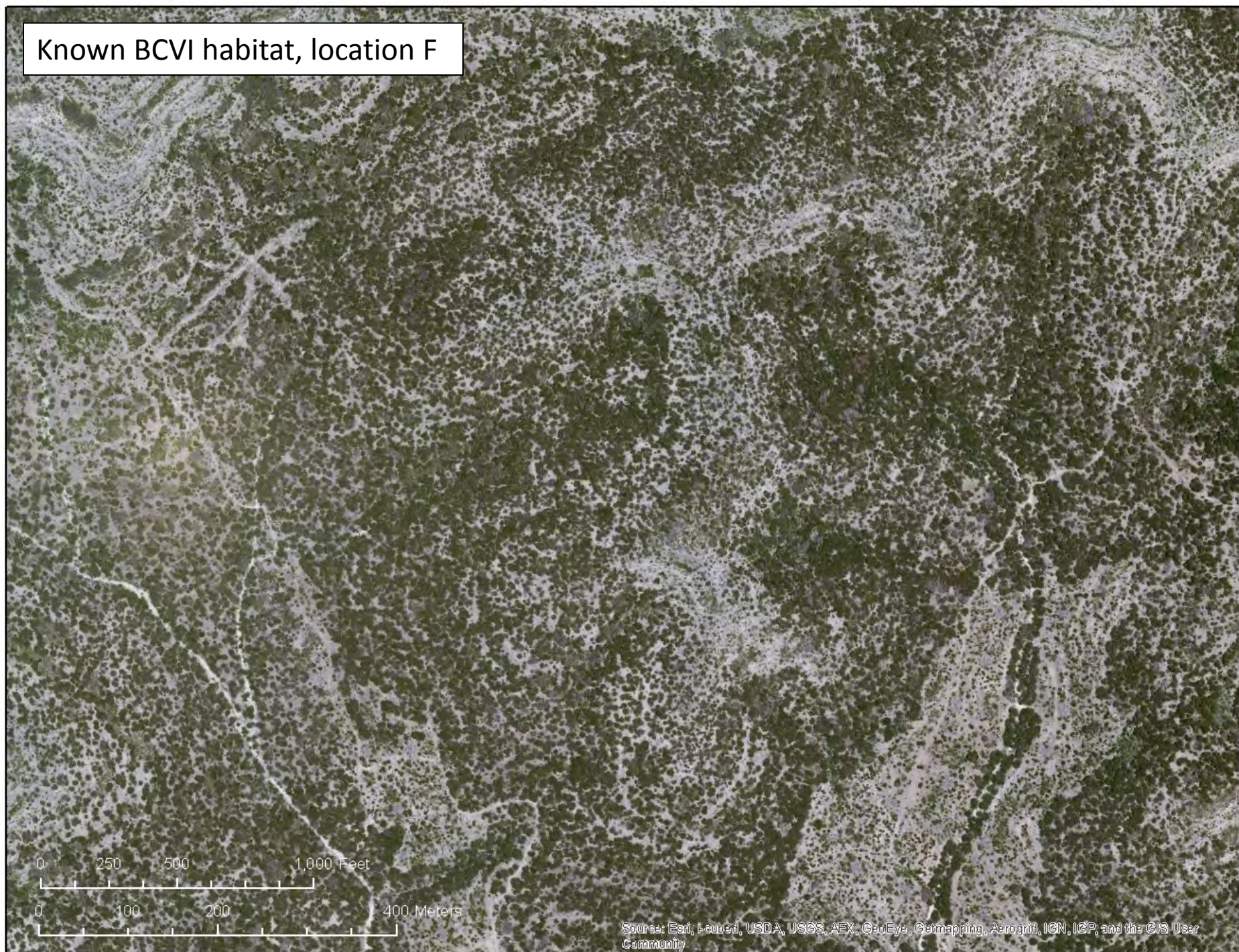


Known BCVI habitat, location F





Known BCVI habitat, location F





# Known BCVI habitat, location G





# Known BCVI habitat, location G



Source: Esri, DeLid, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community



Known BCVI habitat, location H





Known BCVI habitat, location H





# Known BCVI habitat, location I



Source: Esri, DeLid, USDA, USGS, AEX, GeoEye, Geomapping, AeroGrid, IGN, IGP, and the GIS User Community

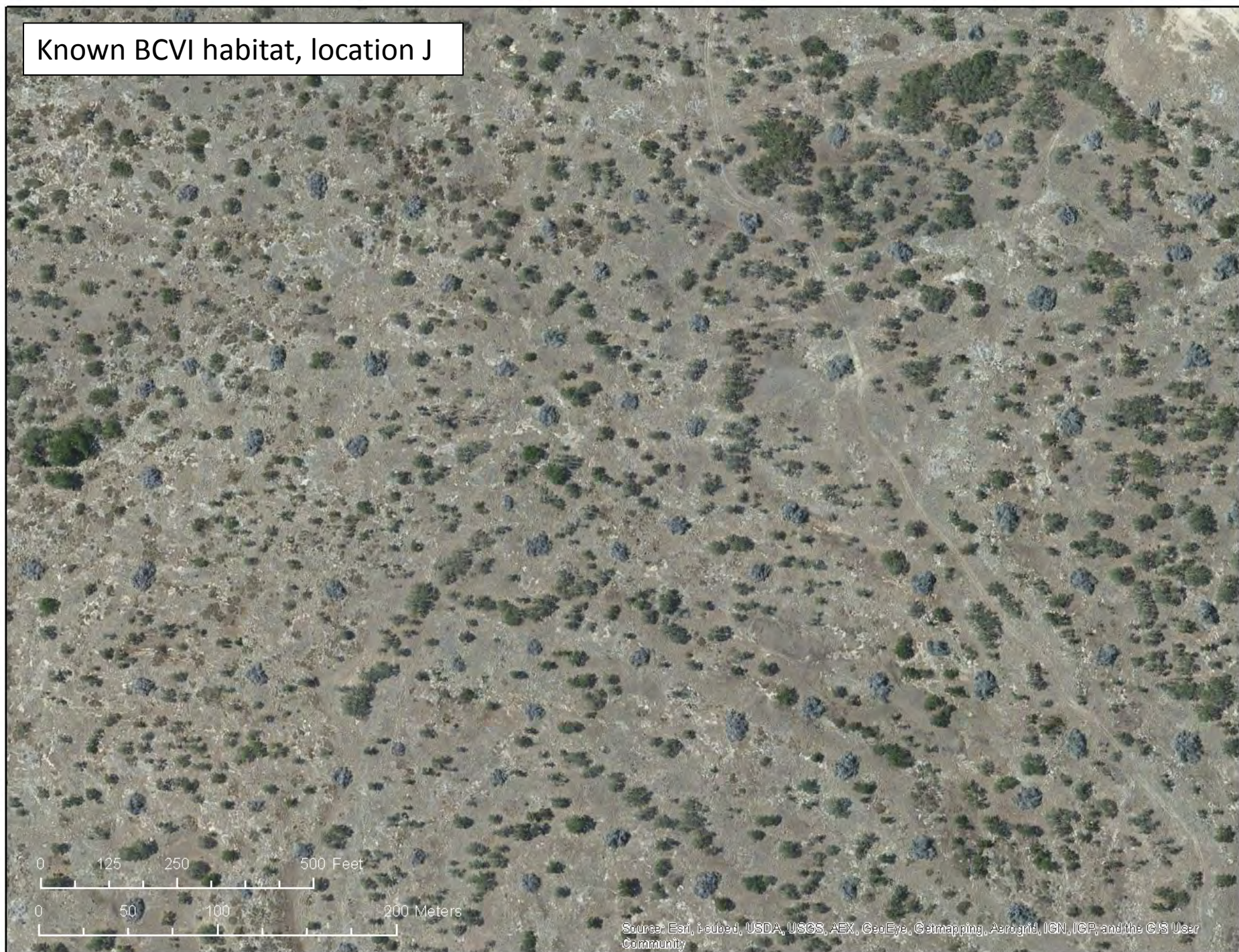


# Known BCVI habitat, location I





# Known BCVI habitat, location J



Source: Esri, DeLorme, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community



# Known BCVI habitat, location J





Known BCVI habitat, location K



Source: Esri, DeLorme, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community



# Known BCVI habitat, location J



Source: Esri, DeLorme, USDA, USGS, AEX, GeoEye, Getmapping, Aergrid, IGN, IGP, and the GIS User Community



# Known BCVI habitat, location L



0 125 250 500 Feet

0 50 100 200 Meters

Source: Esri, DeLorme, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community



# Known BCVI habitat, location L



Source: Esri, Esri.com, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community



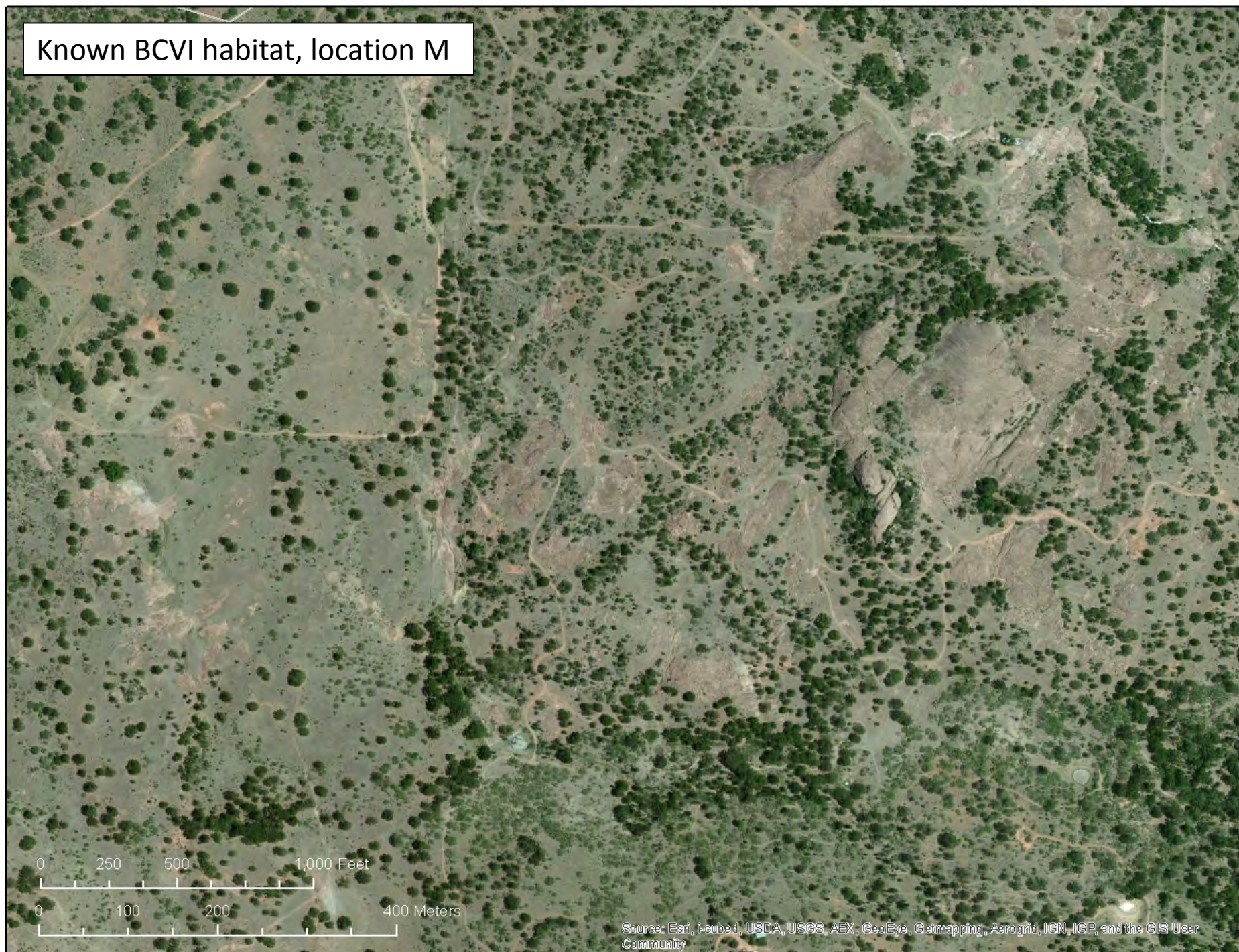
# Known BCVI habitat, location M



Source: Esri, Facebook, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community



# Known BCVI habitat, location M





# Known BCVI habitat, location N



0 125 250 500 Feet

0 50 100 200 Meters

Source: Esri, DeLorme, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community



Known BCVI habitat, location N





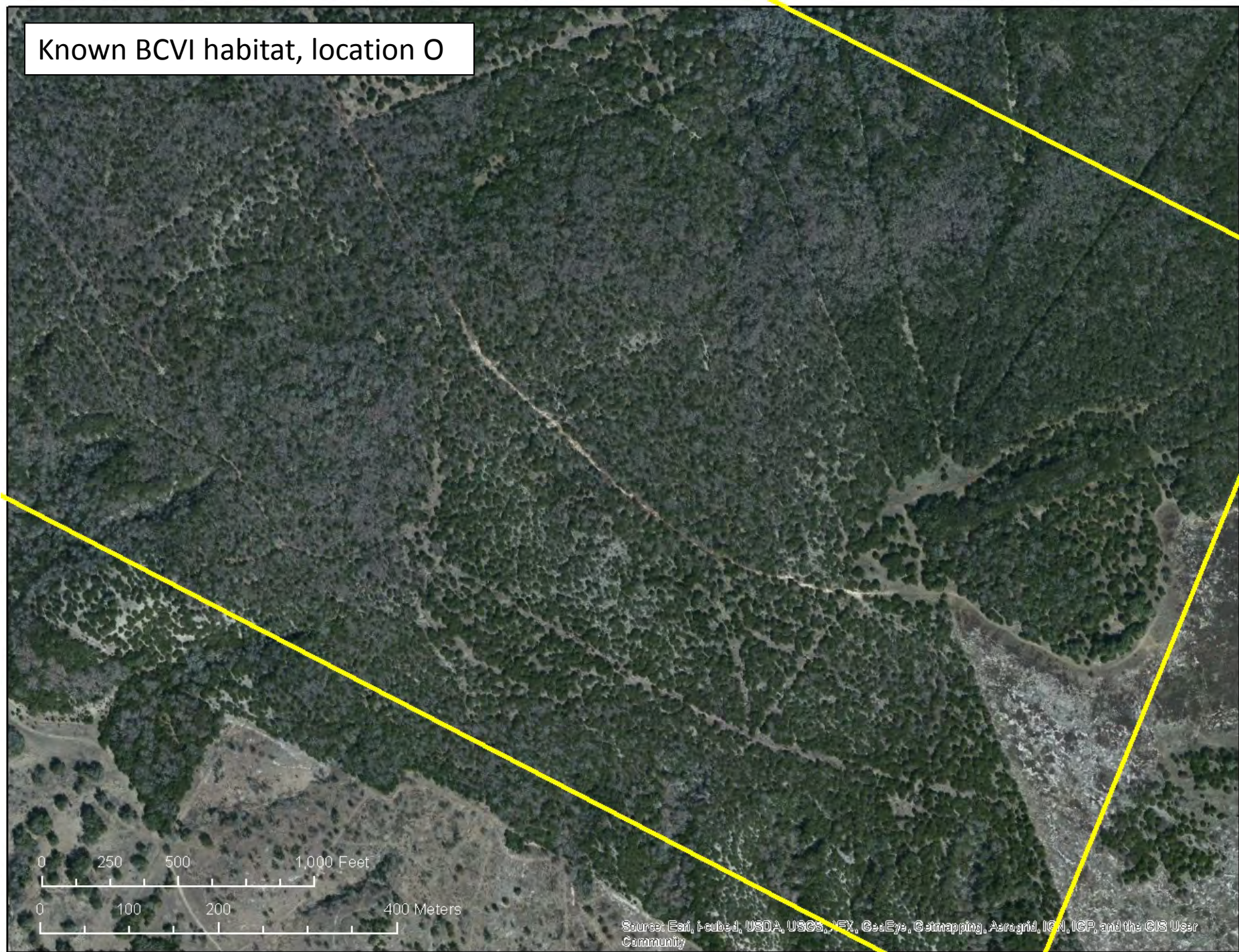
# Known BCVI habitat, location O



Source: Esri, DeLorme, USDA, USGS, AEX, GeoEye, Getmapping, Aergrid, IGN, IGP, and the GIS User Community



# Known BCVI habitat, location O





## Appendix H.

Monitoring framework for recovery of golden-cheeked warblers and black-capped vireos in Texas.

A. J. Campomizzi<sup>1</sup>, M. L. Morrison<sup>2</sup>, R. N. Wilkins<sup>1</sup>

January 2013

<sup>1</sup> Institute of Renewable Natural Resources, Texas A&M University, College Station, TX, USA.

<sup>2</sup> Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, TX, USA.

### OBJECTIVES

The purpose of this document is to provide guidance toward a monitoring framework and effort needed to acquire appropriate metrics for assessing broad-scale status and trends of black-capped vireos (*Vireo atricapilla*; hereafter BCVI) and golden-cheeked warblers (*Setophaga chrysoparia*; hereafter GCWA). Although much research has been conducted on these species, a monitoring program to provide decision-makers with information on specific metrics for assessing species recovery is not in place. We outline an overall approach for monitoring status and trends of habitat, occupancy, abundance, and reproduction for both species within their breeding range in Texas. Additionally, we outline field methods for monitoring each metric.

We ran power analyses for each metric, using existing data, to provide information about the effort needed to obtain sample sizes to detect trends of potential biological importance. Our power analyses provide information about the number of samples, and thus effort, needed to assess particular effect sizes (i.e., percent change in a response variable) over particular time periods. Results of each power analysis should be interpreted as guidelines for target sample sizes when planning monitoring and re-evaluated as data are collected. We first provide our recommended monitoring approach including results of power analyses, followed by how results of analyses can be used for decision-making, key definitions, and methods used for power analyses.

### RECOMMENDED MONITORING APPROACH

The overall monitoring plan is a comprehensive assessment of the status and trends for both species within each recovery region across their range in Texas (i.e., inferential, population monitoring; Thompson et al. 1998). Sampling under this plan would occur in randomly selected sampling units throughout each recovery region such that appropriate inferences can be made for each region and across the species' range in Texas.

For each metric below, we provided power analyses using 1- and 2-tailed statistical tests for monitoring trends annually over 5, 10, and 20 year periods. We also provide results of power analyses for monitoring GCWA occupancy, as an example, conducted every year, second year, or third year. Two-tailed tests are typical in ecology because researchers want to know if a trend is positive or negative over time and the direction of the response is unknown. However, 1-tailed tests can be useful in monitoring if the goal is to assess if a trend is either positive or negative, but not necessarily either. For example, one could use a 1-tailed test if the interest is in determining if abundance is decreasing, setting a null hypothesis that abundance is stable or increasing and data to the contrary are needed to reject that hypothesis. All things being equal, 1-tailed tests have more power to detect a trend than 2-tailed tests, although in one direction only. Additionally, equivalence testing may be useful for testing for absence of a trend among years using 2 1-tailed tests. It is likely that measures for a metric are different among years (i.e., not exactly the same) but the question is: can we reject the statistical null hypothesis that the magnitude of the trend is outside of an effect size considered important by researchers (MacKenzie and Kendall 2002, Dixon and Pechmann 2005). For example, researchers might have a research hypothesis that abundance trend is negligible unless it is  $\geq 10\%$  positive or  $\leq 10\%$  negative trend over a particular number of years. Accordingly, 2 statistical null hypotheses can be set to independently test the research hypotheses for positive and negative trend.

### **Estimate change in area of habitat among years**

Estimating area of habitat within Texas serves to identify all habitat to quantify change in area, and number and size of patches available among years. Identifying habitat also narrows the sampling universe for abundance and reproductive performance. Sufficient area of breeding habitat is needed to maintain or increase the number of birds present in each recovery region. Estimating change in area of breeding habitat and habitat fragmentation over time will indicate if an increasing or decreasing trend in these metrics occurs.

### **Estimate change in number of birds among years**

The broadest monitoring program for detecting a change in the number of birds among years may be to monitor changes in distribution. Monitoring occupancy (the probability of a GCWA or BCVI being in a sampling unit) is useful for monitoring distribution (MacKenzie et al. 2002). Occupancy can be used to monitor abundance trends over large geographic areas (MacKenzie et al. 2006, Pollock 2006).

In addition to patch occupancy, density can be estimated to monitor for trend among years.

### **Reproductive performance among years**

Assessment of species recovery is likely to include measures of changes in reproductive performance among years. Particular levels of reproductive success are necessary to maintain populations of birds in each recovery region (Begon et al. 2006b). If abundance trend is stable or increasing then the species is reproducing at adequate levels. However, if abundance trend is decreasing then it is important to know a productivity trend. Data on reproductive performance (e.g., pairing success, nesting success, number of fledglings per territory) can be collected by monitoring reproductive success of nests (Martin and Geupel 1993) and territories (Vickery et al. 1992). The number of fledglings produced per territory per year is one critical parameter for understanding if the birds are reproducing at rates needed to sustain populations (Jones et al. 2005). Monitoring pairing and nesting success is more time consuming because they require more visits to each territory to determine outcome of those variables.

Inferential monitoring of reproductive performance requires proper sampling to acquire unbiased estimates of the parameter of interest, but not identification of individuals (Thompson et al. 1998). Territories can be monitored in a subset of randomly selected sampling units used for occupancy surveys. Monitoring number of fledglings produced per territory may require multiple visits to a territory, but will be more efficient than monitoring nests because it is time consuming to find nests and monitoring requires each nest be checked once every few days to establish nest outcome. Territories in a randomly selected subset of sampling units in each recovery region used for patch occupancy surveys could be visited to delineate territories when birds are pairing. About a month later, when young may begin fledging, territories could be visited several times, depending on detection probability of fledglings, to determine presence and number of fledglings. Although territory size and location vary throughout the breeding season, the goal of estimating number of fledglings per territory is largely unaffected by shifting territory boundaries.

## **MONITORING FOR GCWA**

Units of study design for each metric (a definition for each term is in the definitions section):

1. Habitat
  - a. Target population: all GCWA habitat in Texas
  - b. Sampling universe: all known GCWA habitat in Texas
  - c. Sampling frame: all patches of GCWA habitat
  - d. Sampling unit: patch of habitat
  - e. Element: pixel in aerial imagery
2. Abundance, occupancy
  - a. Target population: all GCWA in Texas
  - b. Sampling universe: all known GCWA habitat in Texas

- c. Sampling frame: all patches of GCWA habitat
  - d. Sampling unit: patch of habitat
  - e. Element: individual GCWA
3. Reproduction
- a. Target population: all GCWA territories
  - b. Sampling universe: all known GCWA habitat in Texas
  - c. Sampling frame: all known patches of habitat in Texas
  - d. Sampling unit: patch of habitat
  - e. Element: territory or nest

### **Estimate change in area of habitat among years**

Estimating area of habitat within Texas serves to identify all patches of GCWA habitat to quantify change in area of habitat, and number and size of patches available among years.

A patch of GCWA habitat can be defined as a contiguous area of oak-juniper (*Quercus sp.-Juniperus sp.*) woodland and can be identified with aerial imagery using GIS (Collier et al. in press). Remote sensing data and GIS can be used to estimate area of habitat and changes among years as new imagery becomes available. Over time, we expect habitat will be lost in some areas (e.g., fire, plant diseases, human developments) and gained in others (e.g., growth of vegetation, restoration areas). Estimating area of habitat each year will provide estimates for assessment of change in area among years. Fragmentation among years can be monitored by quantifying such metrics as mean or median patch size, number of patches, and mean nearest neighbor distance (Davidson 1998). For example, if area of habitat is consistent among years and patch size is decreasing, then fragmentation is increasing. Various scenarios are possible and can be addressed by estimating area and number of habitat patches among years.

### **Estimate change in number of birds among years**

Relationships between patch occupancy and patch characteristics (e.g., patch size) can be established to estimate the probability of occupancy in each patch for monitoring abundance trends (Morrison et al. 2010).

Monitoring patch occupancy can occur in patches selected in a stratified random sampling method based on recovery region. A lower bound can be set on patch size selected for sampling because many small patches exist that are smaller than territory size, < 3 ha (Ladd and Gass 1999), where GCWA occupancy is unlikely (Collier et al. in press, Butcher et al. 2009, Collier et al. 2010, TAMU unpublished data). Monitoring patch occupancy of GCWA is efficient because detection probability (probability of detecting an individual if it is present) of GCWA in patches is high (0.7 for 1 observer on 1 visit to a patch; Collier et al. in press). Therefore, 2 observers simultaneously and independently searching a patch, listening for GCWA have a 0.09 probability of not detecting a GCWA if one is present ( $(1-0.7)^2$  or one minus detection probability on one visit raised to the power of the number of visits; MacKenzie 2005). Patch occupancy surveys should be conducted mid-March to mid-May from sunrise to noon to maximize detection probability (Collier et al. 2010).

In addition to patch occupancy, density of GCWA can be estimated to assess abundance trend. Change in number of GCWA among years indicates if abundance is decreasing, stable, or increasing. Trend in number of GCWA in each recovery region can be determined by estimating number of birds within available habitat in multiple years. The number of birds can be viewed as a function of density (birds per ha) and area of habitat. GCWA density can be estimated using a field-based, point sampling method combining distance sampling with mark-recapture analyses (Laake et al. in press). Multiple points can be monitored within a patch to estimate mean, patch-specific density. Then, density can be extrapolated to area of habitat available to the species to estimate abundance (Mathewson et al. in press).

*Power analysis.*— Power analysis methods are described below in the analysis methods section. Power to detect a trend in patch occupancy among years increased as the number of patches monitored increased, trend in occupancy increased from 10 to 20%, and as number of years of monitoring increased



from 5 to 10 to 20 years (Figure 1A). For example, we estimated that monitoring occupancy in about 225 patches for a 2-tailed test or 150 patches for a 1-tailed test in each recovery region in each year for a 10% trend over 10 years would have 0.8 power to detect the trend in occupancy (Figure 1A, 1B). Also, we found power to detect a trend increased as the annual interval for monitoring increased from every year to every second or third year (Figure 1C for 2-tailed test, Figure 1D for 1-tailed test). Therefore, the same monitoring effort can have more power to detect a trend if monitoring does not occur every year.

Power to detect a trend in GCWA density in a patch of habitat among years increased as the number of patches monitored increased, trend in density increased from 10 to 20%, and as number of years of monitoring increased from 5 to 10 to 20 years (Figure 2A). For example, we estimated that monitoring density of GCWA in about 250 patches with a 2-tailed test or 150 with a 1-tailed test in each recovery region in each year for a 10% trend in density over 10 years would have 0.8 power to detect the trend in density (Figure 2A, 2B).

### **Reproductive performance among years**

GCWA territories can be visited as described in the recommended monitoring approach section. Patches > 20 ha can be selected for monitoring because productivity has not been detected in smaller patches (Butcher et al. 2009, TAMU unpublished data).

*Power analysis.*— Power to detect a trend in mean number of fledglings per territory in a patch among years increased as the number of patches monitored increased, trend in mean number of fledglings increased from 10 to 20%, and as number of years of monitoring increased from 5 to 10 to 20 years (Figure 3A). We estimated that monitoring number of fledglings in about 400 patches for a 2-tailed test or 250 for a 1-tailed test per recovery region per year would have 0.8 power to detect a 10% trend in average number of fledglings per territory in a patch over 10 years (Figure 3A, 3B).

## **MONITORING FOR BCVI**

Units of study design for each metric in each recovery region:

1. Abundance, occupancy
  - a. Target population: all BCVI in Texas
  - b. Sampling universe: all potential BCVI habitat in Texas
  - c. Sampling frame: grid cells within potential habitat
  - d. Primary sampling unit: 10 km<sup>2</sup> grid cell
  - e. Secondary sampling unit: 300 m<sup>2</sup> grid cell
  - f. Element: individual BCVI
2. Reproduction
  - a. Target population: all BCVI territories
  - b. Sampling universe: all potential BCVI habitat in Texas
  - c. Sampling frame: all BCVI territories in potential habitat
  - d. Sampling unit: territory
  - e. Element: territory or nest

### **Estimate change in area of habitat among years**

Methods for identifying BCVI habitat are not as well developed as for GCWA. However, area of potential habitat can be defined by excluding areas of known non-habitat. Non-habitat can be identified using GIS and includes: open water, developed, barren, pasture and hay, and cultivated from the National Land Cover Database (NLCD) and urban areas from the Texas Natural Resources Information System (TNRIS) and Texas General Land Office (GLO; Appendix A in McFarland et al. 2011). Additionally, areas to monitor can be restricted to a range of canopy cover based on historical occurrence of BCVI. The NLCD canopy cover dataset can be used to identify areas in the Cross Timbers and Edwards Plateau ecoregions with 1 to 40% canopy cover and Chihuahuan Desert with > 10% canopy cover (McFarland et al. 2011). Remaining areas comprise the sampling universe for monitoring abundance and reproductive performance.

### **Estimate change in number of birds among years**

Monitoring occupancy trend among years can be used as a surrogate for abundance trends. We suggest a two-stage sampling design to select sampling units for occupancy monitoring (Thompson 2002, Johnson et al. 2009). This method should be more efficient to implement in the field than one-stage sampling because secondary sampling units are clustered as described below. In stage one, overlaying a grid of 10 km<sup>2</sup> cells on the geographic range of potential habitat defines the sampling frame. Ten km<sup>2</sup> grid cells are then selected in a stratified manner by recovery region. In stage two, a grid of 300 m<sup>2</sup> grid cells is overlaid on selected 10 km<sup>2</sup> grid cells. We suggest 300 m<sup>2</sup> grid cells because an area of this size can contain at least one territory and a biologically relevant sampling unit has yet to be identified (MacKenzie et al. 2004). Occupancy monitoring can occur in randomly selected 300 m<sup>2</sup> grid cells. We recommend stratifying random selection of 300 m<sup>2</sup> grid cells by expected long-term and short-term access to private and public land. A split panel design may be useful because it prescribes some sampling units be monitored in more than one year whereas other sampling units are monitored for one year only (Duncan and Kalton 1987). The split panel is useful in this case because monitoring can occur in multiple years on a set of public and private land where access is likely to continue. Monitoring can occur on another set of sampling units selected each year because permission to access these properties is likely to be short-term.

Effort is likely best spent on monitoring occupancy in 300m<sup>2</sup> sampling units with 2 observers independently and simultaneously conducting area searches for BCVI presence. Detection probability is likely to be higher than for a typical point count because the time-period is longer and observers traverse the grid cell rather than listening from one location. Detection probability is likely to be high in areas with high density of BCVI where individuals are found in clustered distributions (McFarland et al. 2011). A removal design may be helpful, wherein once a BCVI is detected in a 300 m<sup>2</sup> grid cell, the cell does not need to be revisited because presence has been established. However, if a BCVI is not detected on the first visit by either observer, then a pair of observers revisits the cell up to two more times to determine if BCVI are present. If detection probability is 0.5 and a grid cell is visited twice by 2 observers each time, then probability of not detecting a BCVI if one is present is  $0.06 = (1-0.5)^4$ . If detection probability is as low as 0.3 and 2 observers visit a grid cell 3 times, then probability of not detecting a BCVI when it is present is  $0.1 = (1-0.3)^6$ . Probability of detecting a BCVI if it is present in a 300 m<sup>2</sup> grid cell is unknown, but multiple visits to a grid cell enable estimation of detection probability to correct for biases of naïve, observed occupancy.

Trend in BCVI density among years can be monitored by recording the maximum number of males detected in each 300 m<sup>2</sup> sampling unit during each year. Number of males can be recorded during area searches used for monitoring occupancy. Because area of habitat is difficult to define in BCVI, data can be analyzed for a trend in density rather than abundance. Occupancy surveys resulting in unoccupied grid cells establish density as zero. Density may remain stable in areas with high abundance even as range-wide abundance decreases if BCVI are clustering in available habitat because birds continue to establish territories near each other. However, we expect a corresponding decrease in range-wide density because less area of available habitat would be occupied.

*Power analysis.*— Power to detect a trend in occupancy among years increased as number of grid cells monitored increased, trend in occupancy increased from 10 to 20%, and as number of years of monitoring increased from 5 to 10 to 20 years (Figure 4A). For example, we estimated that monitoring occupancy in about 125 300 m<sup>2</sup> grid cells for a 2-tailed test and 50 grid cells for a 1-tailed test in each recovery region in each year for a 10% trend over 10 years would have 0.8 power to detect the trend in occupancy (Figure 4A, 4B).

Power to detect a trend in density among years increased as number of grid cells monitored increased and as number of years of monitoring increased from 5 to 10 to 20 years (Figure 5A). For example, we estimated that monitoring occupancy in about 2,800 300 m<sup>2</sup> grid cells for a 2-tailed test or 2,200 for a 1-tailed test in each recovery region in each year for a 20% trend over 10 years would have 0.8 power to detect the trend in density (Figure 5A, 5B).



### **Reproductive performance among years**

Territories in a randomly selected subset of occupied 300 m<sup>2</sup> grid cells in each recovery region used for occupancy surveys could be visited repeatedly to determine presence and number of fledglings as describe above in the recommended monitoring approach section. To monitor parasitism frequency, territories would need to be visited about twice per week starting when BCVI are pairing until the end of the breeding season to find and monitor nests (Martin and Geupel 1993). Monitoring nests will also provide an estimate of number of fledglings per territory because number of nestlings prior to fledgling will likely be known.

*Power analysis.*— Power to detect a trend in mean number of fledglings per territory among years increased as number of territories monitored increased and as number of years of monitoring increased from 5 to 10 to 20 years (Figure 6A). We estimated that monitoring number of fledglings in about 600 territories for 2-tailed test and 450 for 1-tailed test per recovery region per year would have 0.8 power to detect a 20% trend in average number of fledglings per territory over 10 years (Figure 6A, 6B).

Power to detect a trend in parasitism frequency among years increased as the number of nests monitored increased, the trend increased from 10 to 20%, and as number of years of monitoring increased from 5 to 10 to 20 years (Figure 7A). We estimated that monitoring about 200 nests for 2-tailed tests or 100 nests for 1-tailed tests per recovery region per year would have 0.8 power to detect a 10% trend in parasitism frequency over 10 years (Figure 7A, 7B).

### **USE FOR DECISION MAKING**

Results from power analyses above can be used for planning monitoring of status and trends of GCWA and BCVI in Texas. Logistical constraints (e.g., funding) largely determine effect size that can be detected with acceptable levels of power within various timeframes.

For example, if funds for monitoring can only be secured for GCWA for 5 consecutive years and not enough effort is available to monitor all of the metrics outlined in this document, then effort could be concentrated on monitoring patch occupancy for 5 years. In this case, our 2-tailed power analysis suggests monitoring >300 patches per recovery region would be needed to detect a 10% trend over 5 years with power of 0.8. Alternatively, one may decide to monitor about 200 patches per recovery region, still a substantial effort, and accept that power will be about 0.8 to detect a 20% trend over 5 years. One may decide a 1-tailed test provides adequate information, in which case we estimate that monitoring about 100 patches would have 0.8 power to detect a 20% trend over 5 years. If effort is unavailable for these levels of monitoring, then decisions will need to be made to determine if accepting a lower power or larger effect size is acceptable, if monitoring can be conducted over more years, or if monitoring some metrics under specific logistical constraints is uninformative. One might decide that monitoring each recovery region is too laborious and thus decide to use a simple random sample of patches from the breeding range rather than a stratified random sample on recovery region. This approach would not provide specific information about each recovery region, but we estimate that a simple random sample of 200 patches would have 0.8 power to detect a 20% trend in occupancy in Texas over 5 years using a 2-tailed test. Another way to increase power of tests to detect a trend, without increasing effort, is to monitor every second or third year rather than every year. We provided tables indicating effect sizes with 0.8 power to detect a trend in each metric given sample size for GCWA (Table 1 for 2-tailed tests, Table 2 for 1-tailed tests) and BCVI (Table 3 for 2-tailed tests and Table 4 for 1-tailed tests).

**Table 1.** Effect size with 0.8 power to detect trends in patch occupancy, density (number of GCWA per ha in patch), and fledglings per territory in a patch for different sample sizes (number of patches) over 5, 10, and 20 years for  $\alpha = 0.1$ , 2-tailed test.

<i>n</i>	Effect size (%)								
	Occupancy trend			Density trend			Fledgling trend		
	5 year	10 year	20 year	5 year	10 year	20 year	5 year	10 year	20 year
50	40	25	15	40	25	15	40	25	15
100	30	20	10	30	20	15	35	20	15
150	20	15	10	25	15	10	30	20	15
200	20	15	10	20	15	10	25	15	10
250	20	10	10	20	10	10	25	15	10
300	15	10	10	15	10	10	20	15	10

**Table 2.** Effect size with 0.8 power to detect trends in patch occupancy, density (number of GCWA per ha in patch), and fledglings per territory in a patch for different sample sizes (number of patches) over 5, 10, and 20 years for  $\alpha = 0.1$ , 1-tailed test.

<i>n</i>	Effect size (%)								
	Occupancy trend			Density trend			Fledgling trend		
	5 year	10 year	20 year	5 year	10 year	20 year	5 year	10 year	20 year
50	30	20	15	30	20	5	35	25	15
100	20	15	10	25	15	10	25	20	15
150	20	15	10	20	15	10	25	15	10
200	15	10	10	15	10	10	20	15	10
250	15	10	10	15	10	10	20	10	10
300	15	10	5	15	10	5	15	10	10

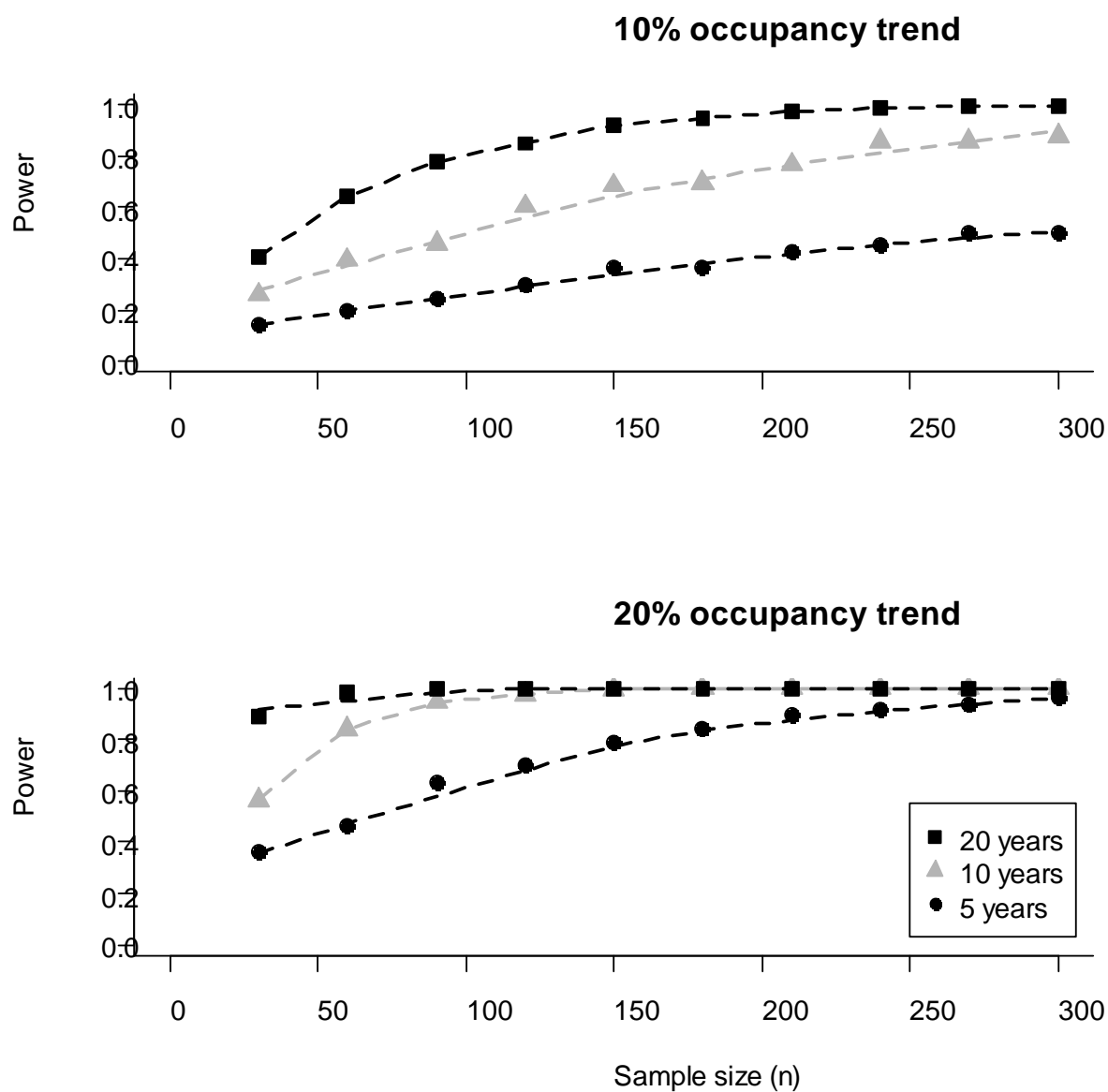


**Table 3.** Effect size with 0.8 power to detect trends in occupancy, density (number of BCVI per 300 m<sup>2</sup> grid cell), fledglings per territory, and cowbird parasitism (number of nests) over 5, 10, and 20 years for  $\alpha = 0.1$ , 2-tailed test.

<i>n</i>	Effect size (%)											
	Occupancy trend			Density trend			Fledgling trend			Parasitism trend		
	5 year	10 year	20 year	5 year	10 year	20 year	5 year	10 year	20 year	5 year	10 year	20 year
50	40	20	15	300	150	100	150	70	50	40	20	20
100	30	15	10	200	125	80	100	60	40	30	20	10
150	20	10	10	150	100	60	80	50	30	30	20	10
200	15	10	10	150	75	60	70	40	30	20	10	10
250	15	10	10	125	75	60	60	40	30	20	10	10
300	15	10	10	125	75	60	50	30	20	20	10	10

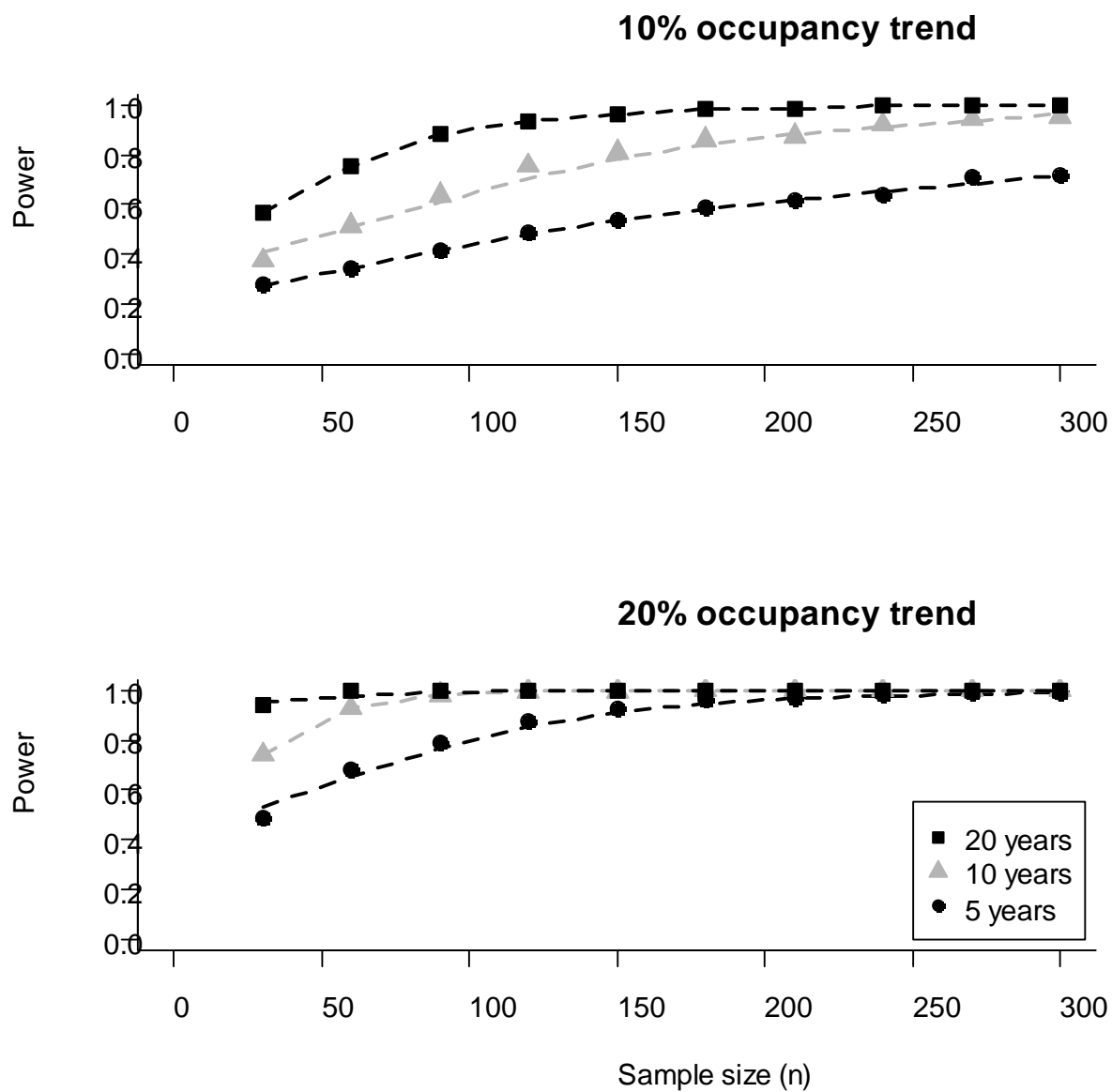
**Table 4.** Effect size with 0.8 power to detect trends in occupancy, density (number of BCVI per 300 m<sup>2</sup> grid cell), fledglings per territory, and cowbird parasitism (number of nests) over 5, 10, and 20 years for  $\alpha = 0.1$ , 1-tailed test. A dash indicates the sample size cannot detect the largest decline possible in effect size (10% for occupancy, a decline from 0.1 to 0.0; 100% for density).

<i>n</i>	Effect size (%)											
	Occupancy trend			Density trend			Fledgling trend			Parasitism trend		
	5 year	10 year	20 year	5 year	10 year	20 year	5 year	10 year	20 year	5 year	10 year	20 year
50	–	10	10	–	–	100	100	50	40	30	20	15
100	10	10	5	–	100	70	70	50	40	25	15	10
150	10	10	5	–	80	60	60	40	30	20	10	10
200	10	5	5	–	70	50	50	40	30	15	10	10
250	10	5	5	100	60	40	50	30	20	15	10	5
300	10	5	5	90	60	40	40	25	20	15	10	5

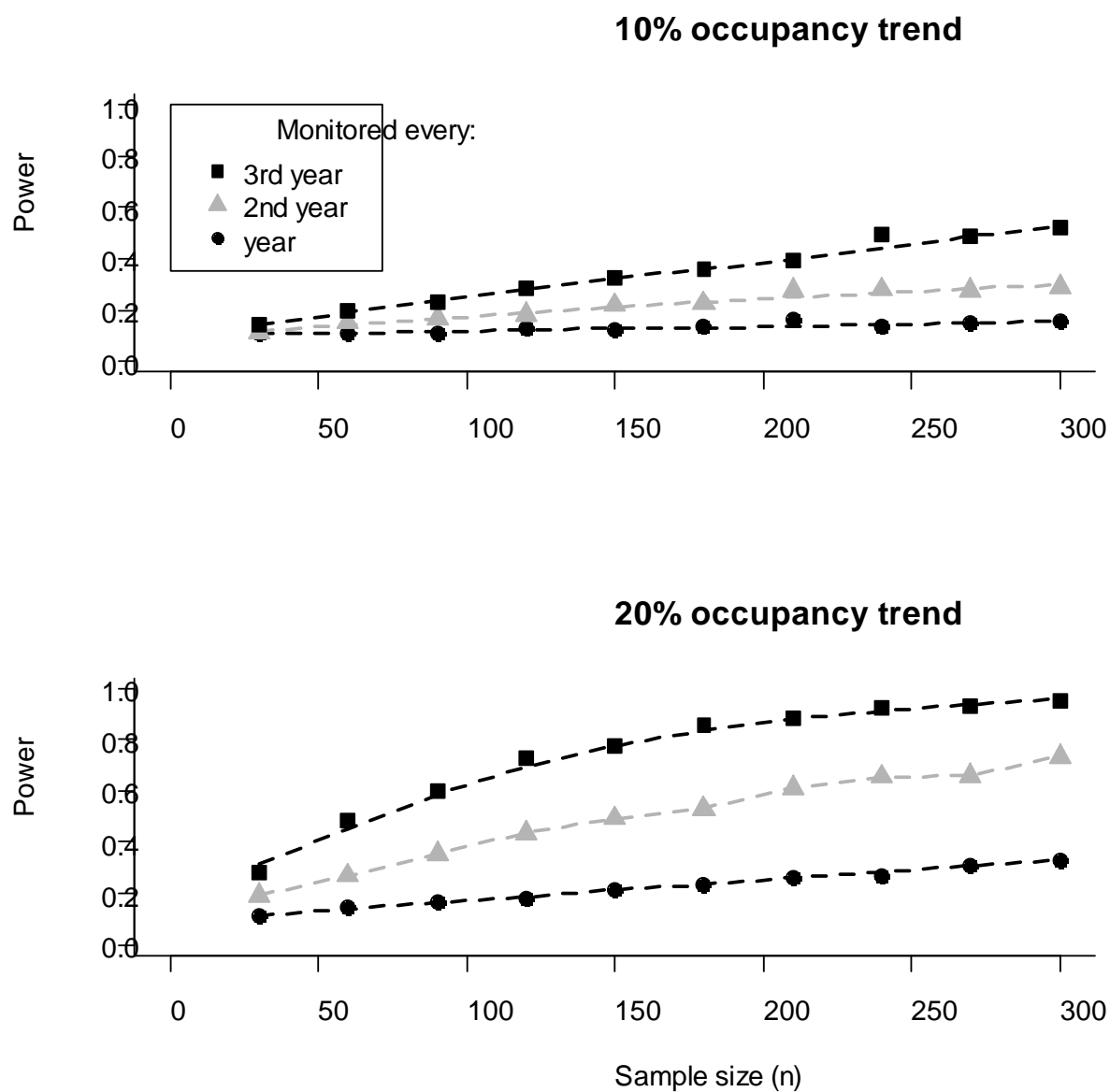


**Figure 1A.** Power and samples size (number of patches of GCWA habitat) estimated to detect a 10 or 20% occupancy trend over 5, 10, and 20 years for  $\alpha = 0.1$ , 2-tailed test.



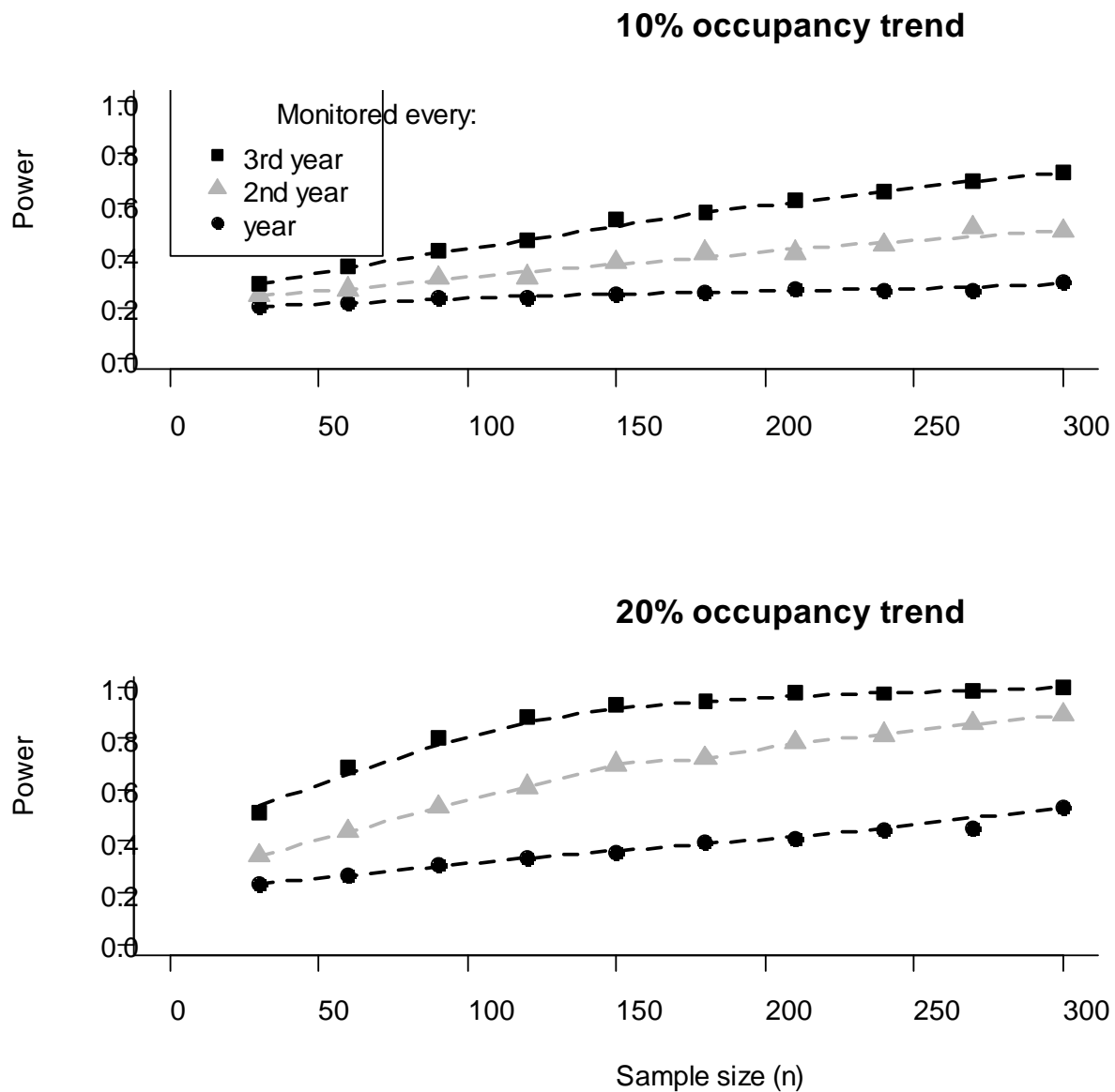


**Figure 1B.** Power and samples size (number of patches of GCWA habitat) estimated to detect a 10 or 20% occupancy trend over 5, 10, and 20 years for  $\alpha = 0.1$ , 1-tailed test.

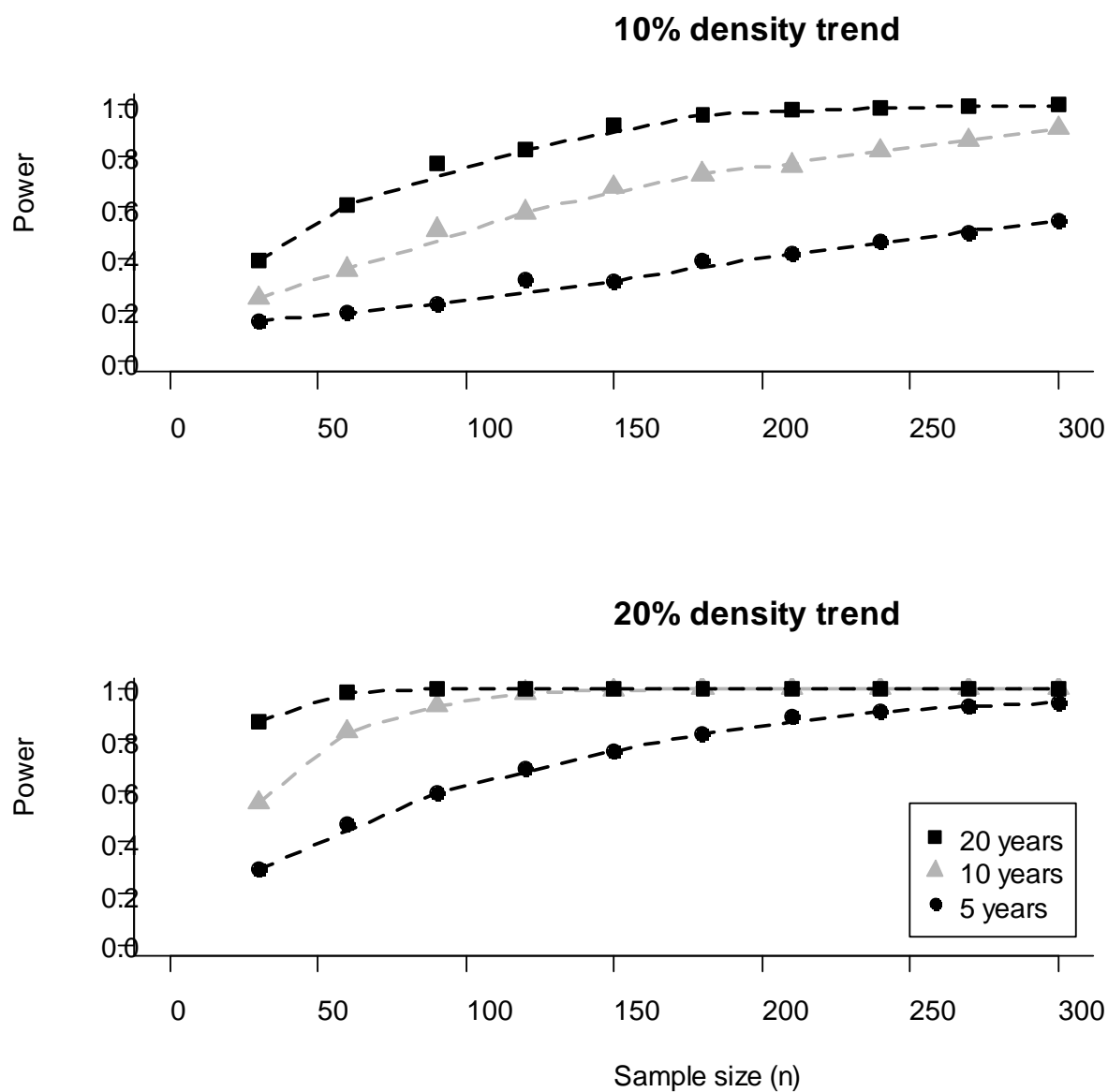


**Figure 1C.** Power and samples size (number of patches of GCWA habitat) estimated to detect a 10 or 20% occupancy trend over 15 years for  $\alpha = 0.1$ , 2-tailed test, assuming monitoring occurs every 1, 2, or 3 years.



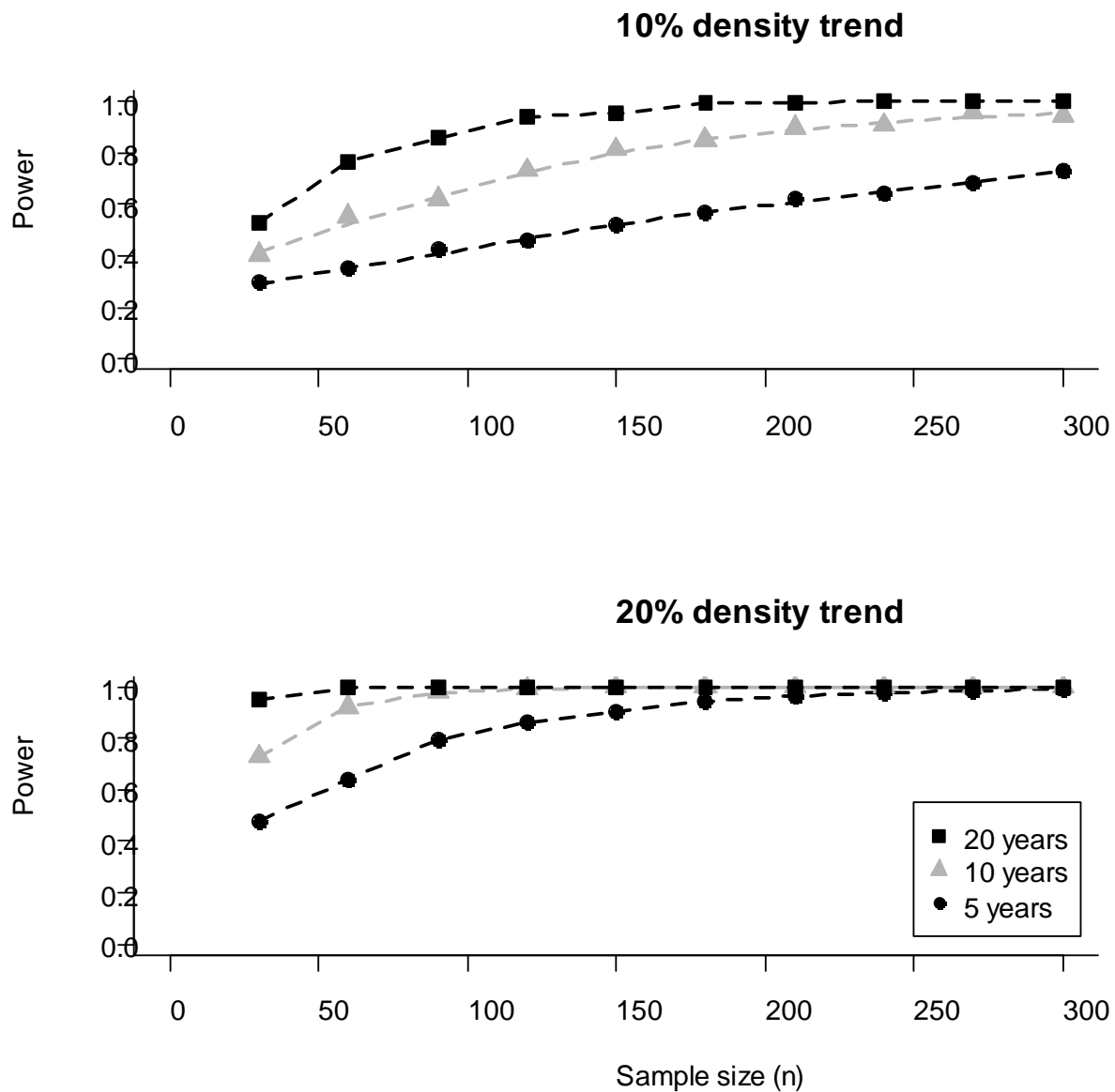


**Figure 1D.** Power and samples size (number of patches of GCWA habitat) estimated to detect a 10 or 20% occupancy trend over 15 years for  $\alpha = 0.1$ , 1-tailed test, assuming monitoring occurs every 1, 2, or 3 years.

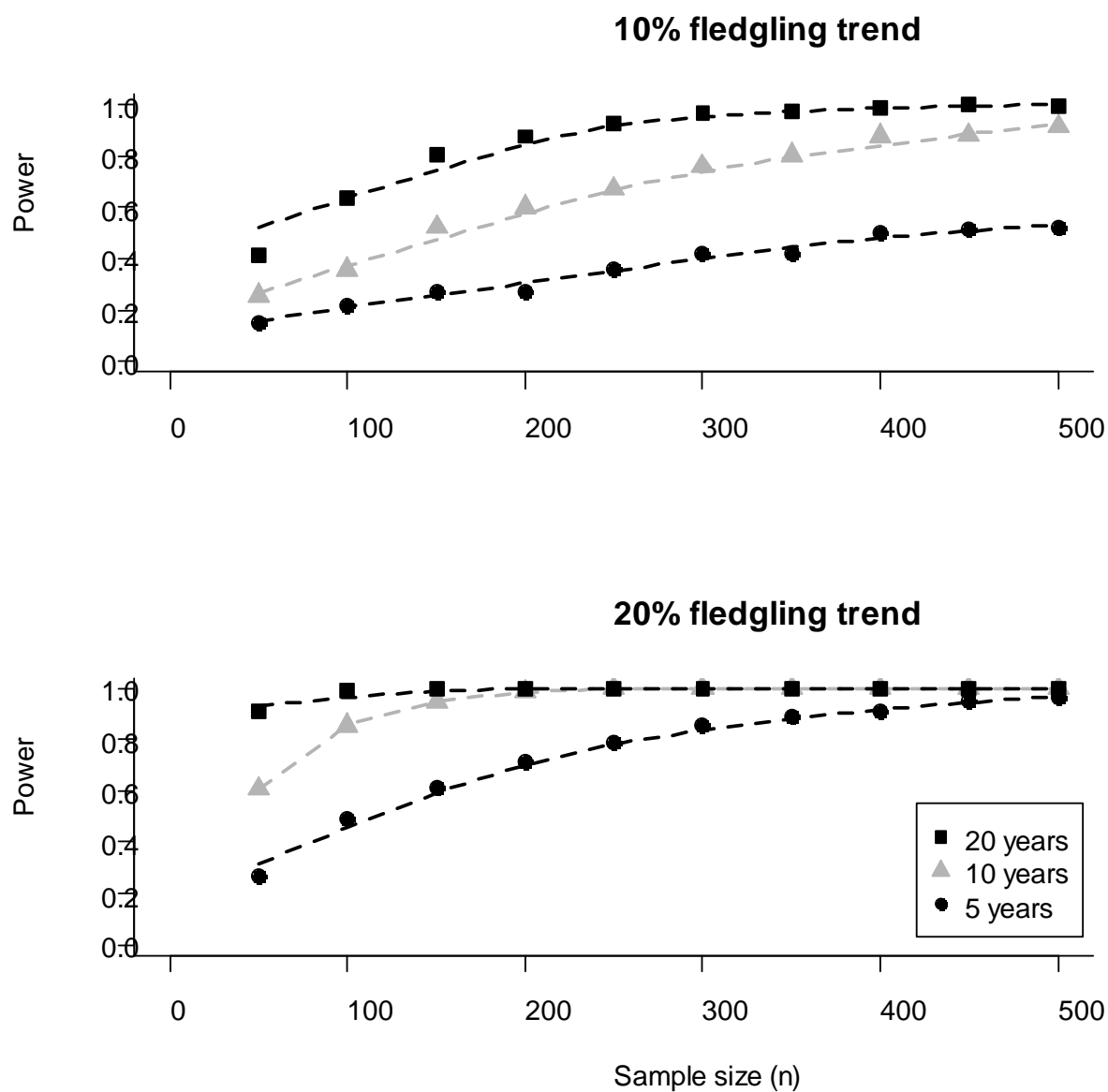


**Figure 2A.** Power and samples size (number of patches of GCWA habitat) estimated to detect a 10 or 20% density trend over 5, 10, and 20 years for  $\alpha = 0.1$ , 2-tailed test.



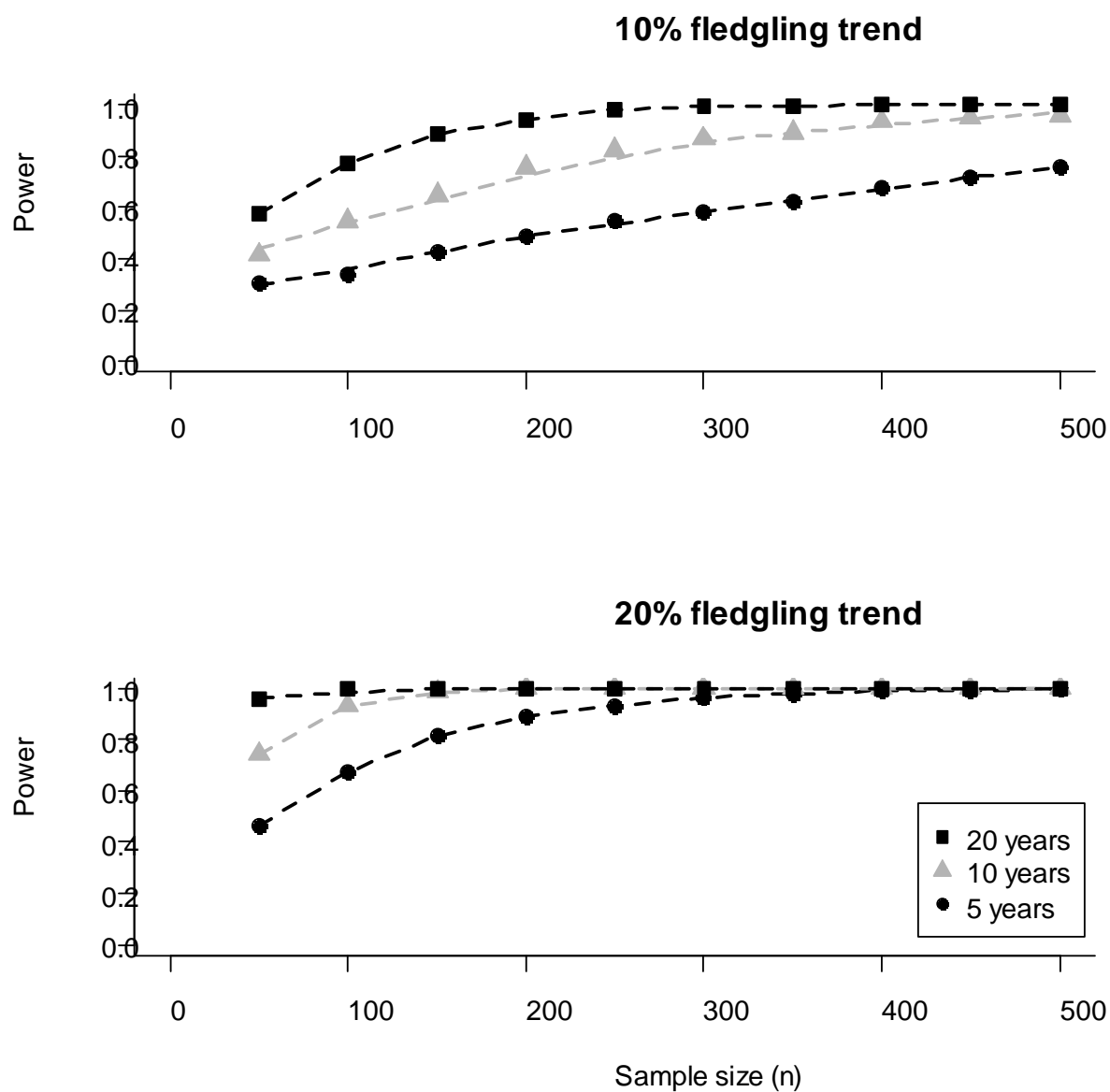


**Figure 2B.** Power and samples size (number of patches of GCWA habitat) estimated to detect a 10 or 20% density trend over 5, 10, and 20 years for  $\alpha = 0.1$ , 1-tailed test.

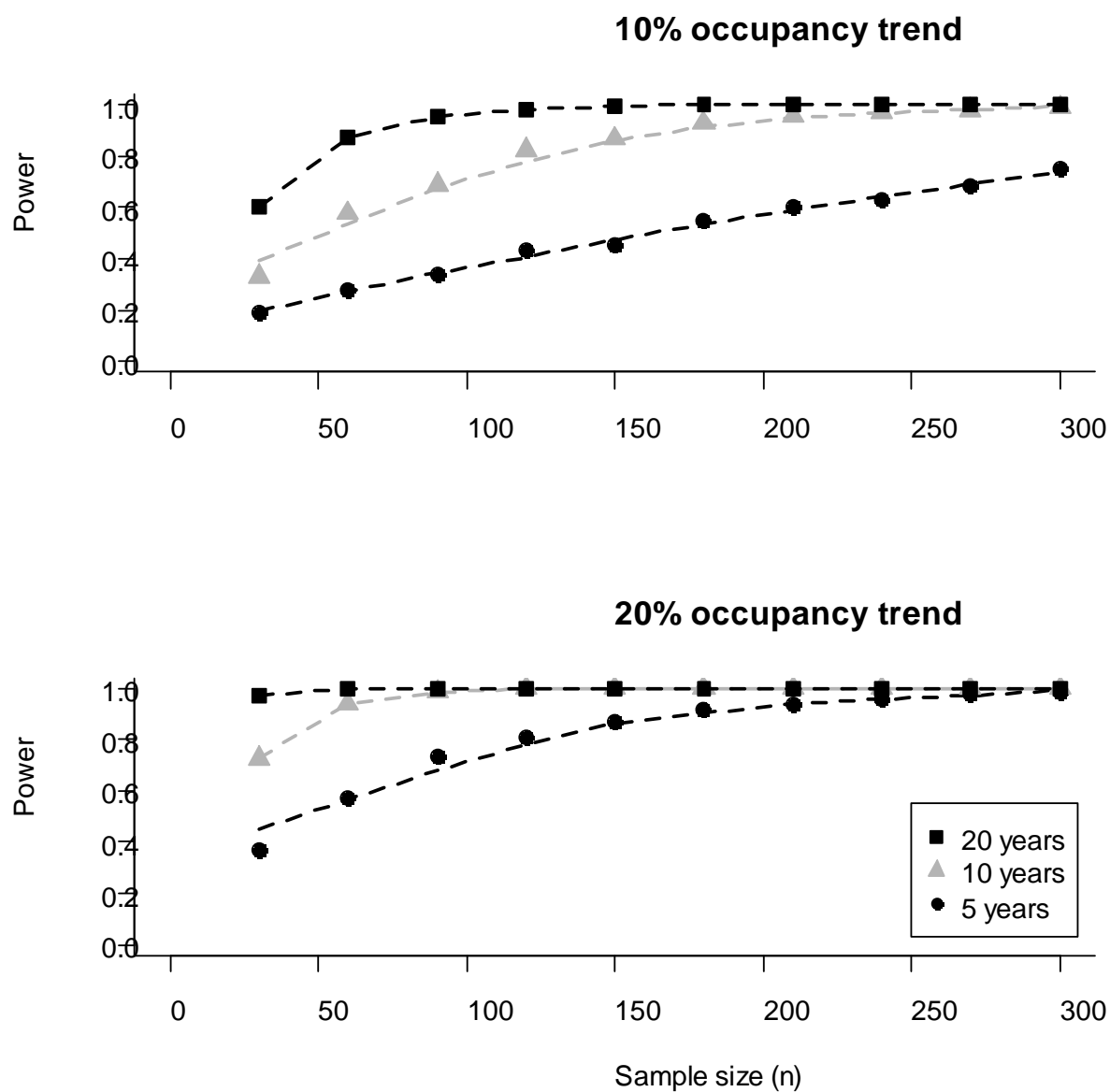


**Figure 3A.** Power and sample size (number of patches) estimated to detect a 10 and 20% change in mean number of GCWA fledglings per territory per patch over 5, 10, and 20 years for  $\alpha = 0.1$ , 2-tailed test.



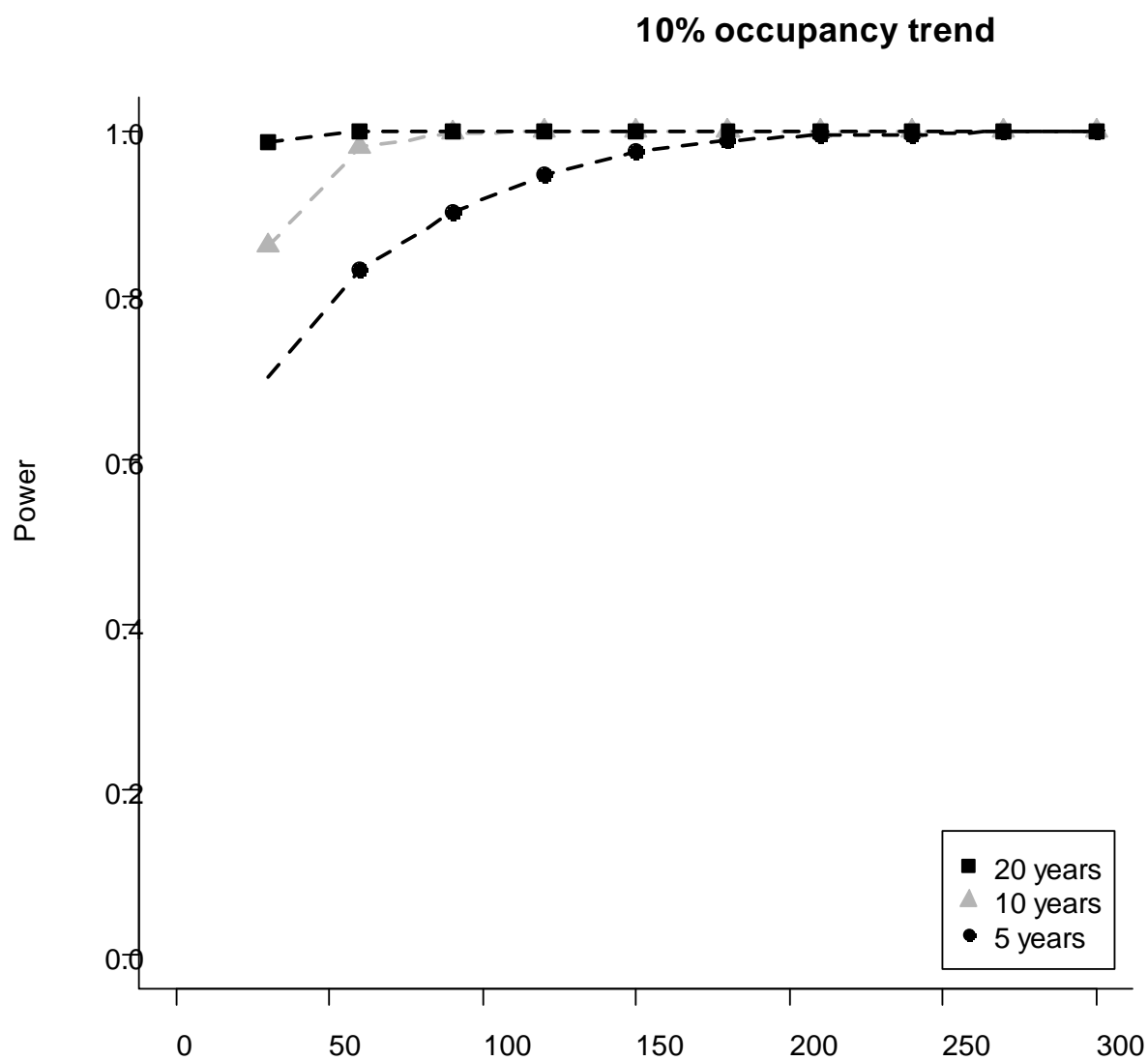


**Figure 3B.** Power and sample size (number of patches) estimated to detect a 10 and 20% change in mean number of GCWA fledglings per territory per patch over 5, 10, and 20 years for  $\alpha = 0.1$ , 1-tailed test.

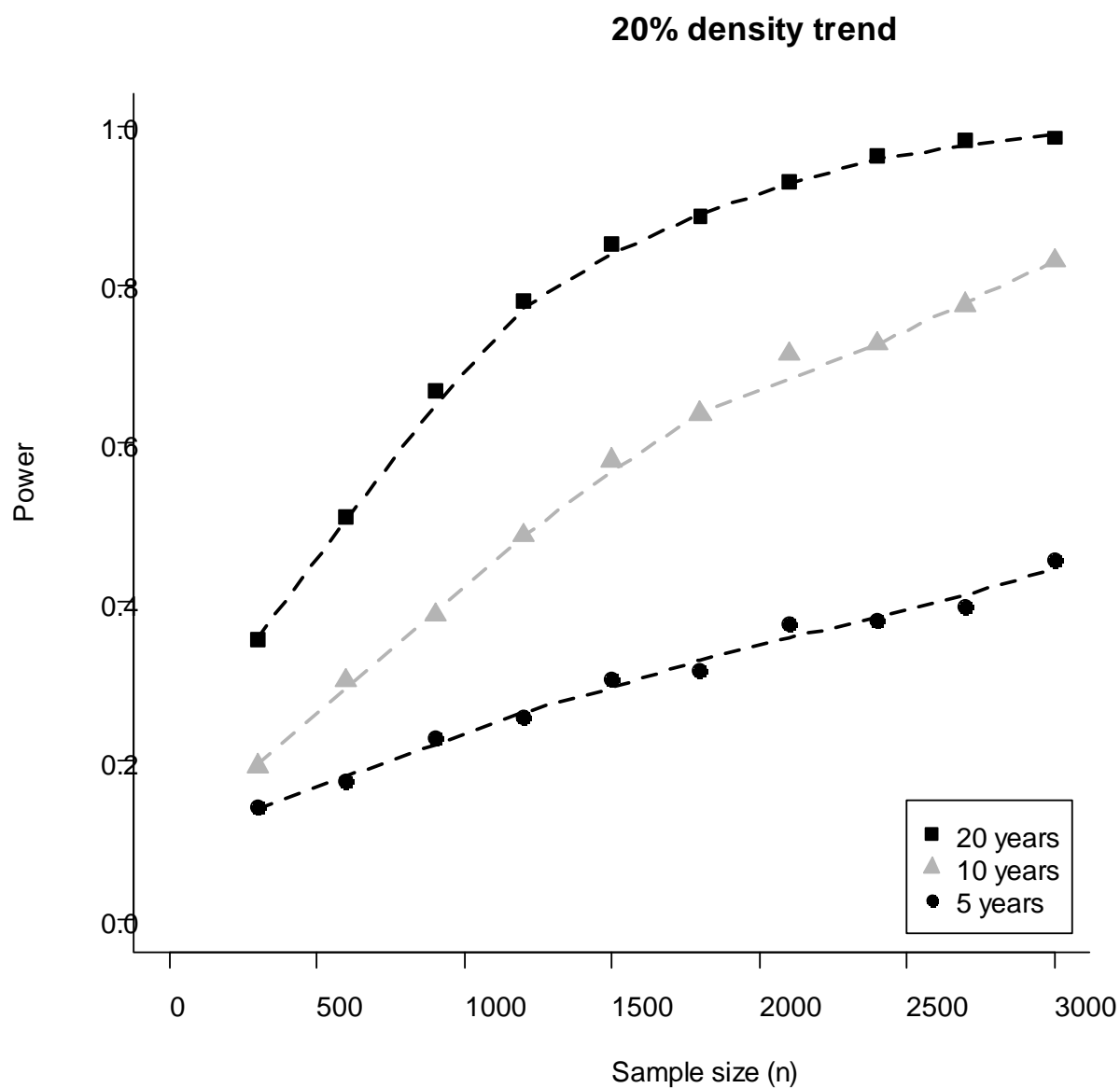


**Figure 4A.** Power and samples size (number 300 m<sup>2</sup> grid cells) estimated to detect a 10 or 20% occupancy trend for BCVI over 5, 10, and 20 years for  $\alpha = 0.1$ , 2-tailed test.



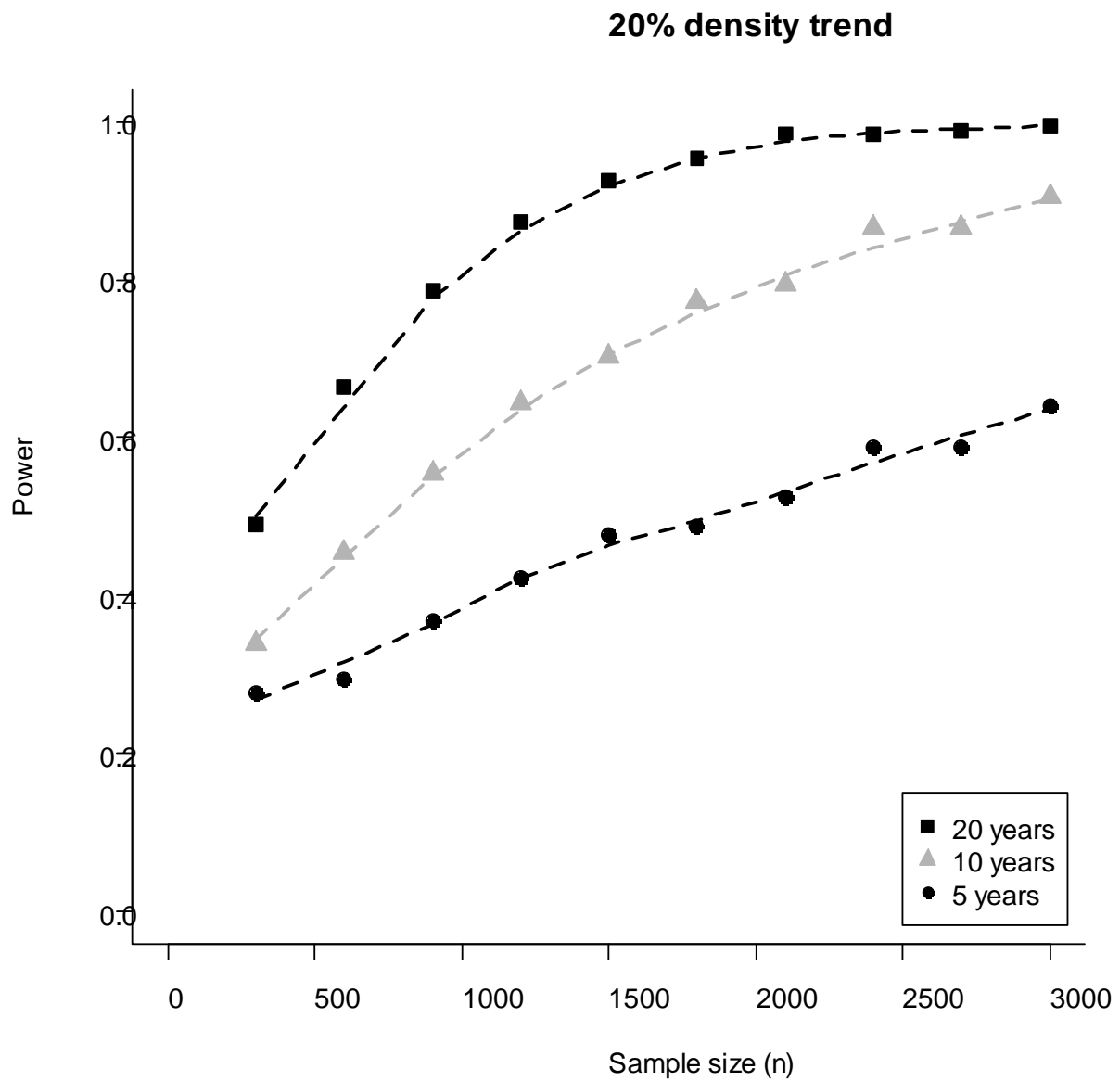


**Figure 4B.** Power and samples size (number 300 m<sup>2</sup> grid cells) estimated to detect a 10 or 20% occupancy trend for BCVI over 5, 10, and 20 years for  $\alpha = 0.1$ , 1-tailed test.

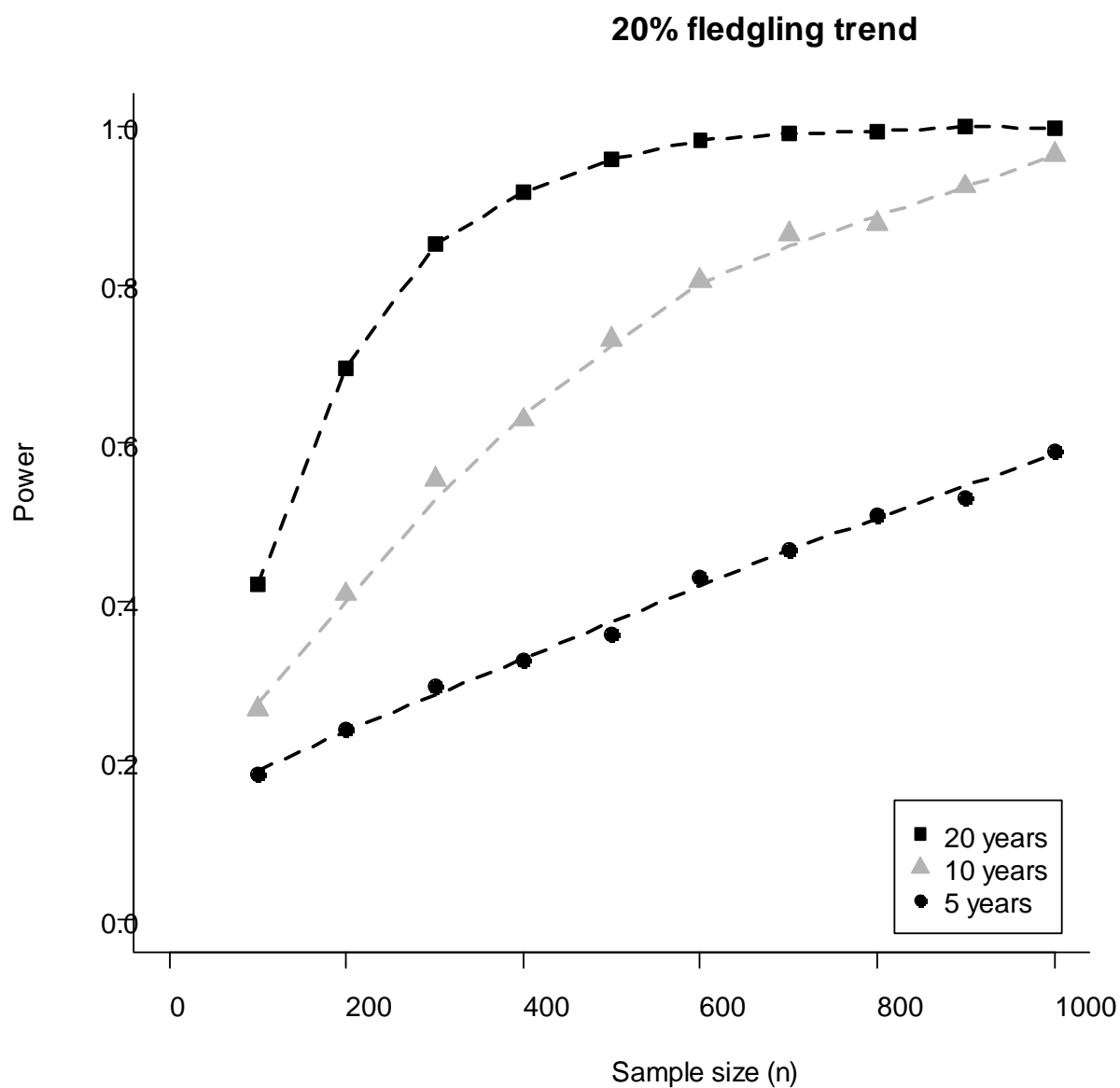


**Figure 5A.** Power and samples size (number of 300 m<sup>2</sup> grid cells) estimated to detect a 20% density trend in BCVI density over 5, 10, and 20 years for  $\alpha = 0.1$ , 2-tailed test.

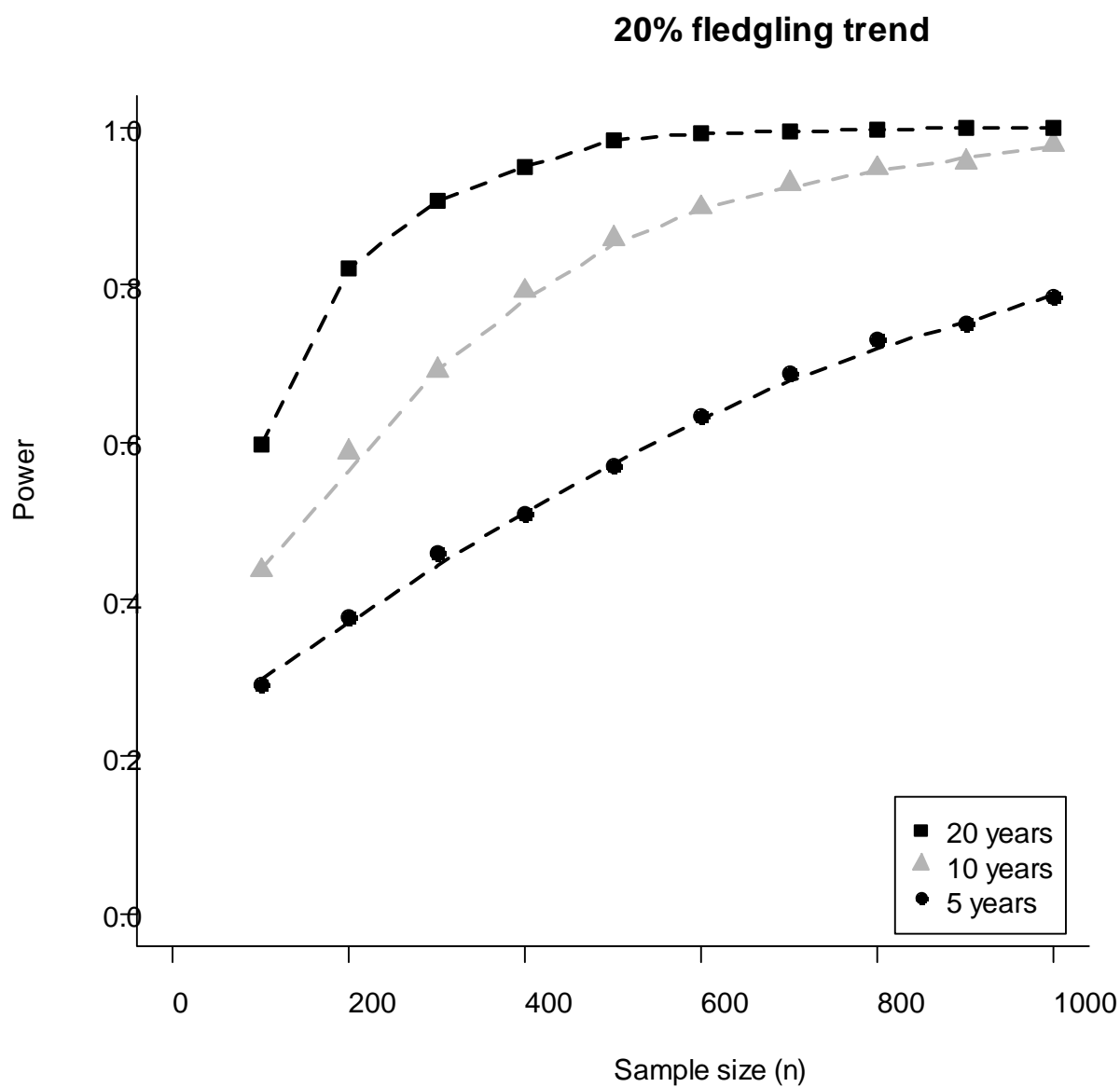




**Figure 5B.** Power and samples size (number of 300 m<sup>2</sup> grid cells) estimated to detect a 20% density trend in BCVI density over 5, 10, and 20 years for  $\alpha = 0.1$ , 1-tailed test.

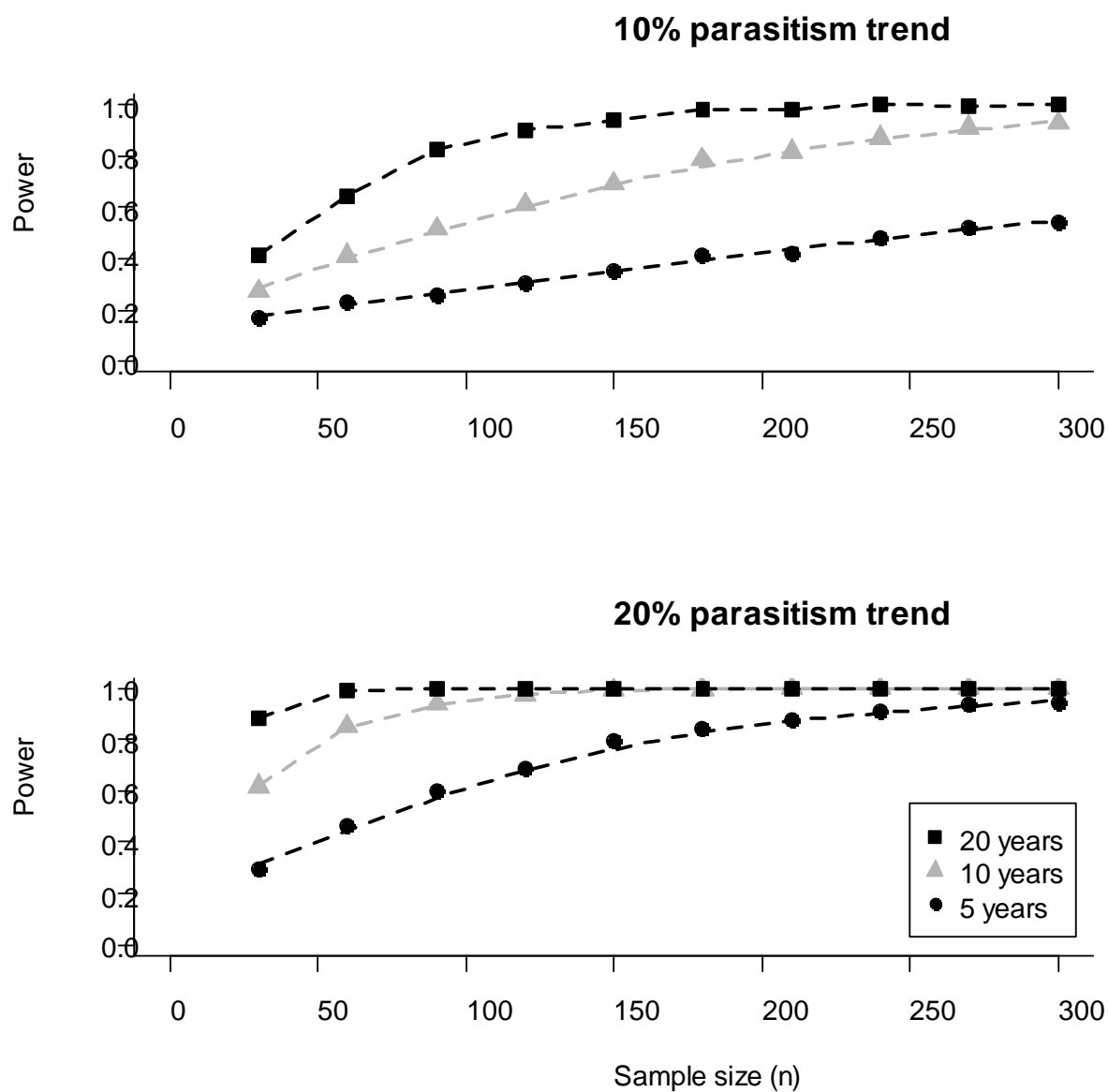


**Figure 6A.** Power and sample size (number of territories) estimated to detect a 20% change in mean number of BCVI fledglings per territory over 5, 10, and 20 years for  $\alpha = 0.1$ , 2-tailed test.

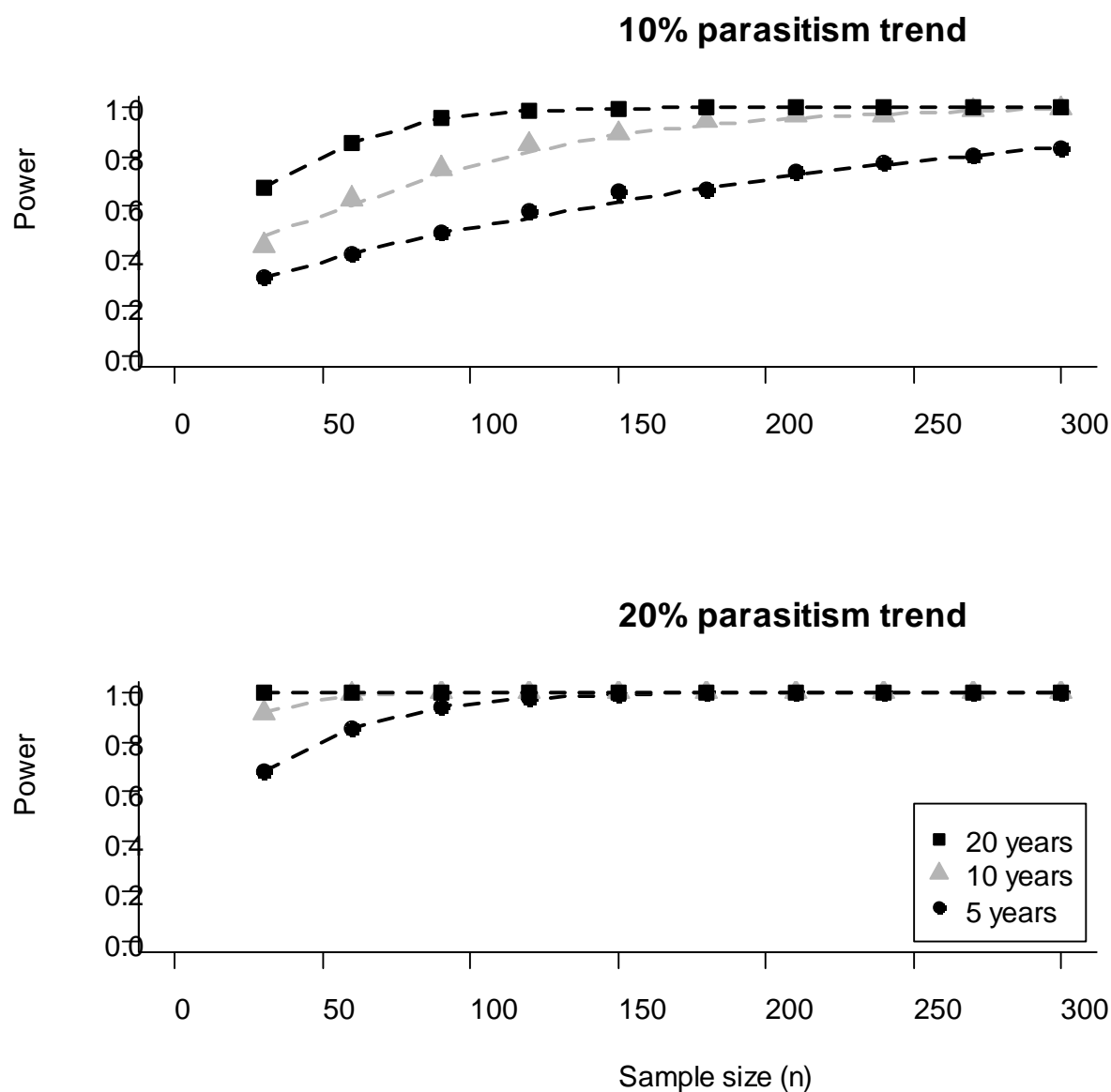


**Figure 6B.** Power and sample size (number of territories) estimated to detect a 20% change in mean number of BCVI fledglings per territory over 5, 10, and 20 years for  $\alpha = 0.1$ , 2-tailed test.





**Figure 7A.** Power and sample size (number of BCVI nests) estimated to detect a 10 and 20% change in parasitism frequency over 5, 10, and 20 years for  $\alpha = 0.1$ , 2-tailed test.



**Figure 7B.** Power and sample size (number of BCVI nests) estimated to detect a 10 and 20% change in parasitism frequency over 5, 10, and 20 years for  $\alpha = 0.1$ , 1-tailed test.

## DEFINITIONS

**Abundance** – number of individuals (Thompson et al. 1998).

**Density** – number of individuals per unit area (Thompson et al. 1998).

**Detection probability ( $p$ )** – probability of detecting a target species on 1 visit to an occupied sampling unit (MacKenzie 2005).

**Element** – an item on which some type of measurement is made or some type of information is recorded (Thompson et al. 1998).

**Habitat** – place where an organism lives (Begon et al. 2006a).

**Occupancy ( $\psi$ )** – the fraction of sampling units in a landscape where a target species is present (MacKenzie and Royle 2005).

**Patch** – contiguous habitat, breaks in habitat are largely human defined.

**Sampling frame** – a complete list of sampling units (Thompson et al. 1998).

**Sampling unit** – a unique collection of elements (Thompson et al. 1998).

**Sampling universe** – space and time containing target population.

**Target population** – all elements contained within some defined space and time (Thompson et al. 1998).

**Trend** – an important change, in both magnitude and direction, in average number of animals over a defined period of time (Thompson et al. 1998).



## REFERENCES

- Begon, M., C. R. Townsend, and J. L. Harper. 2006a. Ecology, from individuals to ecosystems. Fourth edition. Blackwell Publishing Ltd, Malden, Massachusetts, USA.
- Begon, M., C. R. Townsend, and J. L. Harper. 2006b. Life, death and life histories. Pages 89–131 in Ecology: from individuals to ecosystems. Fourth edition. Blackwell Publishing, Malden, Massachusetts, USA.
- Bolker, B. M. 2008. Stochastic simulation and power analysis. Pages 147–168 in Ecological models and data in R. Princeton University Press, Princeton, New Jersey, USA.
- Butcher, J. A., M. L. Morrison, D. Ransom, R. D. Slack, and R. N. Wilkins. 2009. Evidence of a minimum patch size threshold of reproductive success in an endangered songbird. *Journal of Wildlife Management* 74:133–139.
- Collier, B. A., J. E. Groce, M. L. Morrison, J. C. Newnam, A. J. Campomizzi, S. L. Farrell, H. A. Mathewson, R. T. Snelgrove, R. J. Carroll, and R. N. Wilkins. Predicting patch occupancy in fragmented landscapes at the rangewide scale for endangered species: an example of an American warbler. *Diversity and Distributions*: in press.
- Collier, B. A., M. L. Morrison, S. L. Farrell, A. J. Campomizzi, J. A. Butcher, K. B. Hays, D. I. MacKenzie, and R. N. Wilkins. 2010. Monitoring golden-cheeked warblers on private lands in Texas. *Journal of Wildlife Management* 74:140–147.
- Davidson, C. 1998. Issues in measuring landscape fragmentation. *Wildlife Society Bulletin* 26:32–37.
- Dixon, P. M., and J. H. K. Pechmann. 2005. A statistical test to show negligible trend. *Ecology* 86:1751–1756.
- Duncan, G. J., and G. Kalton. 1987. Issues of design and analysis of surveys across time. *International Statistical Review* 55:97–117.
- Field, S. A., A. J. Tyre, and H. P. Possingham. 2005. Optimizing allocation of monitoring effort under economic and observational constraints. *Journal of Wildlife Management* 69:473–482.
- Johnson, D. H., J. P. Gibbs, M. Herzog, S. Lor, N. D. Niemuth, C. A. Ribic, M. Seamans, T. L. Shaffer, W. G. Shriver, S. V. Stehman, and W. L. Thompson. 2009. A sampling design framework for monitoring secretive marshbirds. *Waterbirds* 32:203–215.
- Jones, J., P. J. Doran, L. R. Nagy, and R. T. Holmes. 2005. Relationship between Mayfield nest-survival estimates and seasonal fecundity: a cautionary note. *Auk* 122:306–312.
- Laake, J. L., B. A. Collier, M. L. Morrison, and R. N. Wilkins. Point-based mark-recapture distance sampling. *Journal of Applied Biological and Environmental Statistics*: in press.
- Ladd, C., and L. Gass. 1999. Golden-cheeked warbler (*Dendroica chrysoparia*). The Birds of North America, number 420. The American Ornithologists' Union, Washington, D. C., and Academy of Natural Sciences, Philadelphia, Pennsylvania, USA.
- MacKenzie, D. I. 2005. What are the issues with presence-absence data for wildlife managers? *Journal of Wildlife Management* 69:849–860.
- MacKenzie, D. I., and W. L. Kendall. 2002. How should detection probability be incorporated into estimates of relative abundance? *Ecology* 83:2387–2393.
- MacKenzie, D. I., J. D. Nichols, B. L. Gideon, S. Droege, J. A. Royle, and C. A. Langtimm. 2002. Estimating site occupancy rates when detection probabilities are less than one. *Ecology* 83:2248–2255.
- MacKenzie, D. I., J. D. Nichols, J. A. Royle, K. H. Pollock, L. L. Bailey, and J. E. Hines. 2006. Single-species, multiple-season occupancy models. Pages 183–224 in Occupancy estimation and modeling. Academic Press, Burlington, Massachusetts, USA.
- MacKenzie, D. I., and J. A. Royle. 2005. Designing occupancy studies: general advice and allocating survey effort. *Journal of Applied Ecology* 42:1105–1114.
- MacKenzie, D. I., J. A. Royle, J. A. Brown, and J. D. Nichols. 2004. Occupancy estimation and modeling for rare and elusive species. Pages 149–172 in W. L. Thompson, editor. Sampling rare or elusive species. Island Press, Washington D.C., USA.

- Martin, T. E., and G. R. Geupel. 1993. Nest-monitoring plots: methods for locating nests and monitoring success. *Journal of Field Ornithology* 64:507–519.
- Mathewson, H. A., J. E. Groce, T. M. McFarland, M. L. Morrison, J. C. Newnam, T. R. Snelgrove, B. A. Collier, and R. N. Wilkins. Estimating breeding season abundance of golden-cheeked warblers in Texas. *Journal of Wildlife Management*: in press.
- McFarland, T. M., H. A. Mathewson, M. L. Morrison, R. T. Snelgrove, J. E. Groce, K. Skow, B. A. Collier, and R. N. Wilkins. 2011. Estimating the distribution and abundance of the black-capped vireo in Texas. Texas A&M Institute of Renewable Natural Resources, College Station, Texas, USA.
- Morrison, M. L., R. N. Wilkins, B. A. Collier, J. Groce, H. Mathewson, T. McFarland, A. Snelgrove, T. Snelgrove, and K. Skow. 2010. Golden-cheeked warbler population distribution and abundance. Texas A&M Institute of Renewable Natural Resources, College Station, Texas, USA.
- Pollock, J. F. 2006. Detecting population declines over large areas with presence-absence, time-to-encounter, and count survey methods. *Conservation Biology* 20:882–892.
- R Core Development Team. 2010. R: a language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing; [cited 2010 December 15]. Available from: <http://www.r-project.org>.
- Steidl, R. J., J. P. Hayes, and E. Schaubert. 1997. Statistical power analysis in wildlife research. *Journal of Wildlife Management* 61:270–279.
- Thompson, S. K. 2002. Multistage designs. Pages 143–155 *in* Sampling. Second edition. John Wiley & Sons, New York, New York, USA.
- Thompson, W. L., G. C. White, and C. Gowan. 1998. Basic concepts. Pages 1–43 *in* Monitoring vertebrate populations. Academic Press, San Diego, California, USA.
- Vickery, P. D., M. L. Hunter Jr., and J. V. Wells. 1992. The use of a new reproductive index to evaluate relationships between habitat quality and breeding success. *Auk* 109:697–705.

## APPENDIX 1: ANALYSIS METHODS

### Estimate change in number of birds among years

**GCWA.**— We used simulation models in R for all power analyses (Bolker 2008, R Core Development Team 2010). We tested for trends among years (5, 10, and 20 years) using a linear regression model and thus, have assumptions of a linear regression model (linear trend in number of birds among years, independence among samples within and among years, and constant variance among years). We used a linear model because it was the simplest approach. It will be unknown if monitoring data meet the assumptions of a linear model until data are collected. Possibly, the data may violate some assumptions or follow a non-linear trend, at which time alternative analysis options may need to be explored. Power is the probability of rejecting a false null hypothesis, which means the statistical test detected a trend when there was indeed a trend in the data. For each simulation, we generated data with a built-in trend among years (e.g., for a simulation of a 10% increase in density in 10 years, we increased mean density 1% of the starting density each year). We varied sample size to provide information on effects on power estimates. For all power analyses, we set  $\alpha = 0.1$  and sought a power of 0.8. We increased  $\alpha$  from the normal 0.05 to 0.1 to reduce  $\beta$  (the probability of failing to reject a false null hypothesis) and thus increase power ( $1 - \beta$ ; Steidl et al. 1997). Reducing  $\beta$  is justifiable when monitoring endangered species because it is important for decision makers to know if there is a population trend and less acceptable to be unaware of an actual trend (Field et al. 2005).

We used existing patch occupancy data collected in 2009 in 287 patches spread across the breeding range of GCWA for power analyses of trend in patch occupancy (Morrison et al. 2010). Based on these data, probability of patch occupancy was 0.5. We conducted power analyses for estimating a trend in probability of patch occupancy among years. We estimated sample size needed to detect a 10 and 20% change in patch occupancy (i.e., a change from 0.5 to 0.6 or 0.5 to 0.7) over 5, 10, and 20 years and associated power. Our linear regression model was  $occupancy_i = \beta_0 + \beta_1 year_i + \epsilon_i$ . Thus, the statistical null hypothesis was  $\beta_1 = 0$  for 2-tailed tests and  $\beta_1 \leq 0$  for 1-tailed tests ( $\beta_1$  was the change in the probability of patch occupancy associated with a one unit change in year). We simulated random data as a binomial distribution because GCWA either are or are not detected in a patch.

We used existing density data collected in 2009 from 1,105 point count locations in 279 patches spread across the breeding range of GCWA for power analyses of a trend in density (Mathewson et al. in press). Based on these data, mean density of singing males in a patch was 0.52 / ha and standard deviation was 0.25. We conducted power analyses for estimating a trend in number of males among years. We used males because they are relatively easy to detect compared to females because males sing. An estimate of density with an acceptable variance estimate is needed to be able to detect if density changes among years. We estimated the sample size needed to detect a 10 and 20% change in density of singing male GCWA over 5, 10, and 20 years and associated power. Our linear regression model was  $density_i = \beta_0 + \beta_1 year_i + \epsilon_i$ . Thus, the statistical null hypothesis was  $\beta_1 = 0$  for 2-tailed tests and  $\beta_1 \leq 0$  for 1-tailed tests ( $\beta_1$  was change in mean number of males associated with a one unit change in year). We simulated random data as a normal distribution. Some density estimates in the simulation were  $< 0$  because of the random, normal distribution with mean and standard deviation specified above. We replaced values  $< 0$  with 0 because density estimates cannot be negative.

**BCVI.**— We used data collected in 2009 showing detections of BCVI at 460 of 4,056 point counts spread across the breeding range of BCVI in Texas for power analyses of trend in occupancy of 300 m<sup>2</sup> grid cells (McFarland et al. 2011). Based on these data, probability of patch occupancy was 0.11. We conducted power analyses for estimating a trend in probability of occupancy among years. We estimated sample size needed to detect a 10 and 20% change in occupancy (i.e., a change from 0.1 to 0.2 or 0.1 to 0.3) over 5, 10, and 20 years and associated power. Our linear regression model and null hypothesis test was the same as for GCWA occupancy above. We simulated random data as a binomial distribution because BCVI either are or are not detected in a 300 m<sup>2</sup> grid cell.



We used information from the same data for power analyses for trend in density. Mean abundance from point counts was 0.15 with standard deviation of 0.49. We conducted power analyses using the same procedure for trend in density as described above for GCWA.

### **Reproductive performance among years**

**GCWA.**— We conducted power analyses based on existing territory monitoring data collected in 410 territories in 40 patches across Texas in 2010 (TAMU unpublished data). Based on these data, we simulated random, normal data for power analyses with mean number of fledglings per territory of 1.08 and standard deviation of 0.66. We used the data to estimate the number of patches that would need to be monitored to detect a 10 and 20% change in mean number of fledglings per territory in a patch over 5, 10, and 20 years. Multiple territories would be monitored per patch. Our linear regression model was  $num\ fledge_i = \beta_0 + \beta_1\ year_i + \epsilon_i$ . Thus, we tested the statistical null hypothesis that  $\beta_1 = 0$  for 2-tailed tests and  $\beta_1 \leq 0$  for 1-tailed tests.  $\beta_1$  was change in mean number of fledglings per territory in a patch associated with a one unit change in year.

**BCVI.**— We used data collected in 2010 for monitoring BCVI in 190 territories across Texas (TAMU unpublished data). Based on these data, we simulated random, normal data for power analyses with mean number of fledglings per territory of 0.48 and standard deviation of 0.75. We used the data to estimate the number of territories that would need to be monitored to detect a 20% change in mean number of fledglings per territory over 5, 10, and 20 years. Our linear regression model was  $num\ fledge_i = \beta_0 + \beta_1\ year_i + \epsilon_i$ . Thus, we tested the statistical null hypothesis that  $\beta_1 = 0$  for 2-tailed tests and  $\beta_1 \leq 0$  for 1-tailed tests.  $\beta_1$  was the change in mean number of fledglings per territory associated with a one unit change in year.

We used data collected in 2009 for monitoring 248 BCVI nests for power analyses of trend in parasitism frequency (TAMU unpublished data). Based on these data, we simulated random, binomial data for power analyses with probability of parasitism of 0.27. We used the data to estimate the number of nests that would need to be monitored to detect a 20% change in parasitism frequency over 5, 10, and 20 years. Our linear regression model was  $parasitism\ freq_i = \beta_0 + \beta_1\ year_i + \epsilon_i$ . Thus, we tested the statistical null hypothesis that  $\beta_1 = 0$  for 2-tailed tests and  $\beta_1 \geq 0$  for 1-tailed tests.  $\beta_1$  was change in mean parasitism frequency associated with a one unit change in year.