Drought-related impacts to key species on Pima County Conservation lands

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Pima County Ecological Monitoring Program
Outline

- Ecological monitoring program
- Climate
  - Grid-based precipitation/temperature estimates
- Yellow-billed cuckoos
- Lowland leopard frogs/native fish
- Sonoran desert tortoises
Ecological Monitoring Program
Where is it?
Pima County Conservation Lands

- ~249,475 acres total:
  - ~102,746 ac fee
  - ~146,729 ac lease

- Diverse range of habitats
- Sonoran desert to oak woodland
- Many are potential mitigation lands
Ecological Monitoring Program

How does it work?

Program elements

- Species
- Habitat
- Landscape pattern
- Threats
- Climate
Climate monitoring across County lands

- Retrospectively examine precipitation and temperature across monitoring plots
  - Grid-based climate product (PRISM)
  - Represent full spectrum of County lands
  - Proportionally allocated across bins of elevation/rock content
    - < 2,500 ft (desert)
    - 2,500 – 3,700 ft (thornscrub)
    - 3,701 – 4,500 ft (semi-desert grassland)
    - 4,501 – 6,000 ft (Madrean woodland/Interior chaparral)
Climate monitoring

- 100 monitoring plots
  - Established 2016-2021
  - Categorized by region, strata
- PRISM precip/temp data
  - 1981-present
  - 4 km resolution
- Retrospective trends
  - 5 yr
  - Seasonal
  - Annual
Monsoon precipitation

- 5 yr bins
- No trend
- Most monsoon precip in southwest region
Mean Annual Summer Precipitation – northeast region

- Monsoon precipitation - NE
  - Mean = 199 ± 60 mm
  - Mann-Kendall trend test
    - tau = -0.136
    - p = 0.221
    - Sen’s slope = -0.963

- Decline of 1 mm per year
  - Not significant
- Winter precipitation
  - 5 yr bins
  - Declining trend
  - Across all regions
Mean Annual Winter Precipitation – northeast region

- Winter precipitation - NE
  - 193 ± 99 mm
  - Mann-Kendall trend test
    - \( \tau = -0.295 \)
    - \( p = 0.008 \)
    - Sen’s slope = -3.745

- Decline of 4 mm per year
  - Significant trend
Mean Minimum Temperature – northeast region

- Mean $T_{\text{min}}$ - NE region
  - $9.7 \pm 1.0 \degree C$
  - Mann-Kendall trend test
    - $\tau = 0.615$
    - $p < 0.0001$
    - Sen’s slope = 0.047
    - 95% CI (0.033 – 0.058)

- Increase of 0.05°C/year
  - Significant trend
Mean Maximum Temperature – northeast region

- Mean $T_{\text{max}}$ - NE region
  - $26.6 \pm 0.85^\circ\text{C}$
  - Mann-Kendall trend test
    - $\tau = 0.402$
    - $p = 0.000$
    - Sen’s slope = $0.038$
    - $95\% \text{ CI} (0.019 \text{ – } 0.058)$

- Increase of $0.04^\circ\text{C} \text{ year}^{-1}$
  - Significant trend
Standardized Precipitation-Evapotranspiration Index (SPEI)
Tucson, Arizona (12 month time scale)

SPEI Global Drought Monitor
https://spei.csic.es/map/maps.html
Standardized Precipitation-Evapotranspiration Index (SPEI)
Tucson, Arizona (12 month time scale)

Non-drought
SPEI > -0.5
Yellow-billed Cuckoo monitoring

Cienega Creek Natural Preserve
Bingham Cienega Natural Preserve

Loss of cottonwood canopy 8/3/2021
Yellow-billed Cuckoos – Bingham Cienega Preserve, San Pedro River

Cuckoo detections 2017 vs 2020
Above Avg vs Below Avg Monsoon rainfall (8.57 in vs 1.6 in)
Yellow-billed cuckoos – Cienega Creek Preserve, Cienega Creek

Cuckoo detections 2017 vs 2020

Survey Period

June
July
August

Detections
0 2 4 6 8 10 12 14 16 18 20

2017-CCNP
2020-CCNP

[Chart showing detections in June, July (2017 and 2020), and August (2017 and 2020).]
Yellow-billed cuckoos – Cienega Creek Preserve, Cienega Creek

Cienega Creek stream length

<table>
<thead>
<tr>
<th>Length of flow (miles)</th>
<th>2017</th>
<th>2020</th>
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</thead>
<tbody>
<tr>
<td>June</td>
<td>1.4</td>
<td>1.0</td>
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<tr>
<td>September</td>
<td>2.5</td>
<td>0.7</td>
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</table>

Breeding season rainfall - 2017 vs 2020

Phenology of foraging habitat adjacent to riparian corridor may inform breeding (Wallace et al. 2013)
Yellow-billed cuckoos – a dry monsoon in 2020

- Similar YBCU detections in first half of season
- Fewer detections in 2nd half of season
  - 50% fewer (Bingham Cienega)
  - ~90% fewer (Cienega Creek)
- Repeat surveys in 2023
  - May be less cottonwood canopy than in 2020
Longfin dace and lowland leopard frogs

Buehman and Bullock Canyons

Dace in Buehman Canyon
Buehman Canyon – an unpredictable environment

June 2014

June 2014

July 2020
Buehman Canyon – a variable canyon stream
Buehman Canyon – a variable canyon stream
Buehman/Bullock Canyons – flow length and rainfall prior winter

Pearson’s $r = 0.773$, $p = 0.032$

Pearson’s $r = 0.835$, $p = 0.039$
Longfin dace obs over time 2011 – 2015

Buehman/Bullock Canyon:
Longfin dace obs over time 2016 – 2017

Buehman/Bullock Canyons
Longfin dace obs over time 2018 – 2019

Buehman/Bullock Canyons
Longfin dace obs over time 2020 – 2021

Buehman/Bullock Canyons

Buehman Canyon – 06/21
Leopard frog obs over time 2011 – 2015

Buehman/Bullock Canyon:

Leopard frog egg masses
Leopard frog obs over time 2016 – 2017

Buehman/Bullock Canyons

Upper Buehman Canyon – 06/16
Leopard frog obs over time 2018 – 2019

Buehman/Bullock Canyons
Leopard frog obs over time 2020 – 2021

Buehman/Bullock Canyons

Bullock Canyon – 06/21
Dace and leopard frog population declines

- Loss of one population of longfin dace
- Contraction of area occupied for leopard frogs and dace
- Reduction in population resiliency and redundancy

### Longfin dace

<table>
<thead>
<tr>
<th># Sites obs</th>
<th>Bullock Canyon</th>
<th>Buehman Canyon</th>
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<tr>
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### Lowland leopard frog

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<td>2016</td>
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Sonoran desert tortoises

Tucson Mountain Park
Sonoran desert tortoises
Below Avg vs Above Avg Summer rainfall

Monsoon precipitation – Tucson Mountain Park
2018 = 3.6 inches
2021 = 9.3 inches

Median herbaceous production
2018 = 18.4 lbs/acre
2021 = 55.2 lbs/acre
Wilcoxon test ($W = -3.92$, $z = -3.92$, $p < 0.001$)

Jones et al. 2021
Sonoran desert tortoises
Avg vs Above Avg Summer rainfall

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<th>Year</th>
<th>Adult Mass (g)</th>
<th>Adult length (mm)</th>
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<td>2018 (n = 26)</td>
<td>2,410 ± 100 g</td>
<td>220 ± 4 mm</td>
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<td>2021 (n = 31)</td>
<td>2,447 ± 98 g</td>
<td>233 ± 4 mm</td>
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No significant differences across years
Slopes of mass vs length are the same

Long-lived organism balancing energy/moisture budgets over seasons
Concluding thoughts

- 30 year ecological monitoring program
- Taking the long view is critical
- Much uncertainty for aquatic species
  - Management options may be limited in many cases

Thank You!

Multi-species Conservation Plan
http://webcms.pima.gov/mscp/
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**Mean Temperature trend analysis**

**Precipitation trend analysis**
Longfin dace in Bullock Canyon
Loss of longfin dace in Bullock Canyon

- Observations between 1997 – 2019
- Observed only below cement dam
- 2.7 km downstream to nearest dace obs in Buehman Canyon
- 5.5 km downstream to nearest reliable dace pool in Buehman Canyon
Gila chub

Loss of chub from Cienega Creek Natural Preserve
Gila Chub in Cienega Creek Natural Preserve
Gila Chub in Cienega Creek Natural Preserve
Chub lost in Cienega Creek Natural Preserve

• Observations between 2006 – 2018
• Observed in 5 different pool areas
  • One pool, ‘chub’ pool had the most consistent obs
• Almost all pools dried by August 2020
  • Mostly shallow run habitat
Section 10 Permit Vitals

- 30-year permit
- 44 species
  - 8 Currently listed
  - 36 have the potential to be listed
- **Covered Activities:** County
  - Construction, repair, maintenance of County facilities;
  - Monitoring and land management
  - Ranching