Shot-at Tufted ducks avoid hunted areas:
new insights from the assessment of lead-shot prevalence

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Context: The impact of hunting on natural populations

- Demographic & evolutionary trajectories of populations affected by hunting
  - extinction of mega-faunas,
  - changes in morphology (trophy-hunting…)
  - alteration of life history traits,
  - behavioural responses…
The impact of hunting can be direct
- demographic consequences of the removal of individuals
- stress (immuno-competence…)

or indirect
- lead poisoning through soil contamination by spent lead-shot
Prevalence of ingested and embedded lead-shot in Tufted duck wintering in the Camargue wetlands (1958-74):

- magnitude of the problem in the Camargue wetlands
- vulnerability of diving ducks (compared to dabbling ducks)
- impact of the emergence of commercial hunting in the mid-sixties (increase in hunting pressure?)

Impact on lead-shot on fitness components:

- survival & body-condition
Assessing the impact of embedded and ingested lead-shot pellets on Tufted Ducks

~ 2000 individuals X-rayed and ringed (Research Institute of the Tour-du-Valat, Camargue wetlands, 1958-1974)

 présence and numbers of embedded and ingested lead-pellets
Assessing the impact of embedded and ingested lead-shot pellets on Tufted Ducks
General “properties” of spent lead-shot:

- huge quantities released (150 – 450 pellets per ammunition, up to 100-200 pellets per m²)

- incidentally ingested (mistaken for grit)

- long-term persistence in the soil (settlement rate very slow) and in the flesh

- short-term retention in the digestive track (couple of weeks)

- grinding → solubilisation → absorption → interference with vital functions (death) → shedding
Assessing the impact of embedded and ingested lead-shot pellets on Tufted Ducks

Prevalence of embedded and ingested lead pellets

→ A large number of individuals affected
Assessing the impact of embedded and ingested lead-shot pellets on Tufted Ducks

Temporal evolution of the presence of embedded and ingested lead pellets

- A trend towards an increase over the study period
- Consistent with the emergence of commercial hunting (↑ hunting pressure)
Assessing the impact of embedded and ingested lead-shot pellets on Tufted Ducks

Impact of lead-shot on survival

<table>
<thead>
<tr>
<th>Model</th>
<th>Recovery (r)</th>
<th>Model Rank</th>
<th>AICc</th>
<th>Numb. Par.</th>
<th>δ AICc</th>
<th>cum. weight</th>
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<tbody>
<tr>
<td>NUMB_GIZZARD + YEAR</td>
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<td>age + NUMB_GIZZARD + YEAR</td>
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<tr>
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<td>(.)</td>
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<td>24.60</td>
<td>1.00</td>
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</table>

→ Negative effect of number of ingested lead pellets on survival
Assessing the impact of embedded and ingested lead-shot pellets on Tufted Ducks

Impact of lead ingestion on survival

The increase in ingested lead-shot prevalence did not preclude an increase in survival
Assessing the impact of embedded and ingested lead-shot pellets on Tufted Ducks

Effect on body condition (body mass/wing length)

<table>
<thead>
<tr>
<th>Model</th>
<th>Rank</th>
<th>AIC&lt;sub&gt;c&lt;/sub&gt;</th>
<th>δ AIC&lt;sub&gt;c&lt;/sub&gt;</th>
<th>cum. weight</th>
</tr>
</thead>
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<td>1521.93</td>
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<td>0.52</td>
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<td>sex + age + year</td>
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<tr>
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→ A negative effect of the presence of pellets in the flesh on body condition
Assessing the impact of embedded and ingested lead-shot pellets on Tufted Ducks

Are contaminated individuals (with lead pellets in the digestive tract) more vulnerable to hunting?

→ contaminated individuals should be more prone to be shot/wounded

- a positive correlation between ingested and embedded lead pellets

Rejected: a negative correlation was found instead

- individuals with ingested lead pellets should display higher hunting recoveries rates

Rejected: no effect of lead ingestion on recovery rates
Individuals with lead-shot in the flesh had a lower probability to carry lead-shot pellets in the gizzard!
Assessing the impact of embedded and ingested lead-shot pellets on Tufted Ducks

→ the presence of ingested lead-shot implies contamination on a regular basis

→ individuals without ingested lead-shot feed on non-contaminated/protected areas

→ individuals with lead-shot in the flesh feed on non-hunted areas

→ SHOT-AT INDIVIDUALS AVOID(ED) HUNTED AREAS!
Assessing the impact of embedded and ingested lead-shot pellets on Tufted Ducks

Benefit to avoid hunted areas?
- no evidence for higher survival
- lower hunting recovery rates
→ lower hunting mortality

Costs to avoid hunted areas?
- a lowered body-condition
Assessing the impact of embedded and ingested lead-shot pellets on Tufted Ducks

Conclusions:

- the Camargue among the most contaminated wetland (number of hunters)
- "the most contaminating" (rarity of grit)
- diving ducks more exposed than dabbling ducks
- weaker impact of lead ingestion on survival compared to dabbling ducks (food richer in proteins & CaCO₃)
- hunting affect individual behaviour (with both positive and negative outcome)
Methodological and management issues:

- possible biases in survival estimates (when captures performed on protected areas)
- potential problems of heterogeneity (exposed/non-exposed to hunting)

**Teals wintering in Camargue**: 0.60 ± 0.02 high survival ind.
0.47 ± 0.02 low survival ind.

*Guillemain et al. Condor 2014*

- importance of an adequate proportion of protected areas
- management of protected areas optimised for food production/availability
Thank you for your attention

Many thanks to the numerous people which were involved in data collection and processing