THE EFFECTIVENESS OF MITIGATION MEASURES FOR REDUCING WILDLIFE VEHICLE COLLISIONS AND PROVIDING CONNECTIVITY, JAPAN

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Subject of study: Landscape ecology, Road ecology, Mammalogy
BACKGROUND

Raccoon dog Road-kill

Red Fox Road-kill

Fragmentation forest

Cultivation area
In many countries, several mitigation techniques in use to minimize road-kill, habitat loss, and reduced habitat quality.

In Japan, the significance of road ecology is currently uncertain, and no standard procedures are being used to minimize the detrimental effects that road systems can have on wild mammals.
THE FIRST PART OF OUR WORK

- We studied the ecological impacts of roads in Japan and surveyed the types of wildlife-crossing structures (WCSs) for the target species of wild mammals.
We analyzed the biological and physical factors that contribute to the selection of wildlife-crossing structures (WCSs) by wild mammals.
THE LAST PART OF OUR WORK

- Finally, we will introduce case studies of WCSs.
PART I: THE STATE OF WCSs IN JAPAN
SITE INTRODUCTION

Land area: 377,944 km²
Total road length: 1,271,572 km²
Road density: 3.2 km/km²
PART I: THE STATE OF WCSs IN JAPAN

- Box culvert
- Pipe culvert
- Underpass
- Overpass
- Eco-bridge
- Drift fence
- Planting
- .... others
Part 1: Target species of WCSs for wild mammals

- **Hokkaido**: Large mammal, Arboreal, Bat, others
- **East Japan**: Whole mammal, Large mammal, Sm. & Mid. mammal, Ar.
- **West Japan**: Whole mammal, Large, Small- & Mid- mammal, others
- **Okinawa & Tsushima**: Leopard Cat, Others (crustaceans and turtles)
<table>
<thead>
<tr>
<th>Location</th>
<th>RCS</th>
<th>Incidental facility</th>
<th>Target species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hokkaido, Kitami</td>
<td>Bridge</td>
<td>-</td>
<td>Japanese cryfish</td>
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<tr>
<td></td>
<td>Box culvert</td>
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<tr>
<td>Hokkaido, Obihiro</td>
<td>Box culvert</td>
<td>Bat box</td>
<td>Ussuri whiskered bat</td>
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<td></td>
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<td>Ussuri daubenton's bat</td>
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<td>Long-eared bat</td>
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<td>Lesser tube-nosed bat</td>
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<td>Long-legged whiskered bat</td>
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<td>Asian parti-colored bat</td>
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<td>Large-footed bat</td>
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<tr>
<td>Hokkaido, Obihiro</td>
<td>Ecobridge</td>
<td>-</td>
<td>Japanese squirrel</td>
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<tr>
<td>Hokkaido, Obihiro</td>
<td>Box culvert</td>
<td>Pole for gridding</td>
<td>Japanese flying squirrel</td>
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<td>Hokkaido, Akkeshi</td>
<td>Bridge</td>
<td>Fence</td>
<td>Sika deer</td>
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<td>Miyagi, Naruko</td>
<td>Box culvert</td>
<td>-</td>
<td>Japanese serow</td>
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<tr>
<td>Fukushima, Shimogo</td>
<td>Bridge</td>
<td>Fence</td>
<td>Mammals</td>
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<td></td>
<td>Box culvert</td>
<td></td>
<td></td>
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<tr>
<td>Tochigi, Nikko</td>
<td>Bridge</td>
<td>Fence</td>
<td>Mammals</td>
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<tr>
<td></td>
<td>Box culvert</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yamanashi, Otsuki</td>
<td>Ecobridge</td>
<td>-</td>
<td>Japanese squirrel</td>
</tr>
<tr>
<td>Yamanashi, Hokuto</td>
<td>Ecobridge</td>
<td>-</td>
<td>Japanese dormouse</td>
</tr>
<tr>
<td>Yamanashi, Fujiyoshida</td>
<td>Bridge</td>
<td>-</td>
<td>Mammals</td>
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<td></td>
<td>Box culvert</td>
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<td></td>
<td>Pipe culvert</td>
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<tr>
<td>Oita, Takasakiyama</td>
<td>Overbridge</td>
<td>Planting</td>
<td>Japanese macaque</td>
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<td>Nagasaki, Tsushima</td>
<td>Box culvert</td>
<td>-</td>
<td>Tsushima leopard cat</td>
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<td>Okinawa, Ogimi</td>
<td>Box culvert</td>
<td>-</td>
<td>Land crab, Hermit crab</td>
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<td></td>
<td>Pipe culvert</td>
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<tr>
<td>Okinawa, Kunigami</td>
<td>Box culvert</td>
<td>Fence</td>
<td>Okinawa rail</td>
</tr>
<tr>
<td>Okinawa, Iriomote</td>
<td>Box culvert</td>
<td>-</td>
<td>Iriomote cat</td>
</tr>
</tbody>
</table>
Overpass for midsize mammals in East Japan
Box culvert for large and midsize mammals in East Japan
Bridge under the road for Flying squirrel in Hokkaido
Pole for Flying squirrel in Hokkaido

Bat box
PART I: THE RESULT OF WCSS STATUS IN JAPAN

- WCSs in Japan are mainly **box culverts** intended for **large** (e.g., sika deer *Cervus nippon*) and **mid-sized** (e.g., red fox *Vulpes vulpes*) **mammals**.

- There are few **WCSSs intended for arboreal mammals** (e.g., Japanese squirrel *Sciurus lis*, Japanese dormouse *Glirulus japonicus*, Russian flying squirrel *Pteromys volans orii*).
PART2: MONITORING OF WILDLIFE CROSSING STRUCTURES

- We selected 2 types of road (Toyotomi Bypass and Higashi-fujigoko) from these 86 and set up infrared sensor cameras (film and digital camera) to investigate WCSs use by species of wild mammals.
① What structures?
② Where to set up?
③ How many to set up?
PART2: TYPE OF WILDLIFE CROSSING STRUCTURES

Sites: Toyotomi BP and Hiiagshi-fijigoko express way
PART 2: SPECIES PLOT USING CCA WITH AIC

Plot of Species and WCSs using CCA in TTB

(Code) Sh: Shrew, Mo: Mouse, De: Deer, Ha: Mountain hare, Fo: Fox, Rd: Raccoon dog, Bat: Bats, Ra: Raccoon, Sa: Sable
(Parameter) vlog: Volume of WCSs, drain: Drainage, dis: Distance of WCSs, art: Proportion of artificial land use
PART 2: SPECIES PLOT USING CCA WITH AIC

Plot of Species and WCSs using CCA in HFGE

(Code) Sh: Shrew, We: Wesel, Mo: Mouse, Ra: Raccoon, Rd: Raccoon dog, Ci: Palm civet, Bad: Badger, Ha: Hare, Bo: Bore, Fo: Fox, De: Deer, Bat: Bats, Ma: Marten, Sq: Squirrel

(Parameter) Open: Openness index, drain: Drainage, non_b: Proportion of Non-bush, c-κ: Proportion of artificial land use, c-λ: Proportion of Deciduous forest
PART 2: CAMERA TRAP RESULTS

- The Large-size WCSs were preferred by Large mammals such as deer, boar (*Sus scrofa leucomystax*), and several other species.
- Box culverts were used frequently by mid-size mammals such as raccoon dogs (*Necteleutes procyonoides*), foxes (*Vulpes vulpes*) and masked palm civets (*Paguma larvata*).
- Pipe culverts with drainage were favored by sable (*Martes zibellina*), marten (*Martes melampus*) and rodents Apodemus spp (*Apodemus speciosus, Apodemus argenteus*).
- Preference of WCSs are attributed to physical and biological factors.
Part 3: Case study of the overpass use in Hokkaido, northern Japan

Three overpasses at same site on highway:
For mammals (B1) and for human (B2 and B3)

Can overpass for human contribute to wildlife passage?
Camera trap to understand users between 2015 and 2016
Large and middle mammals used all overpasses (no significant difference)

<table>
<thead>
<tr>
<th>Site</th>
<th>Eurasian red squirrel</th>
<th>Raccoon</th>
<th>Red fox</th>
<th>Raccoon dog</th>
<th>Sable</th>
<th>Least weasel</th>
<th>Sika deer</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>+</td>
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<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<td>B2</td>
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<td>B3</td>
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<td>+</td>
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<td>+</td>
</tr>
</tbody>
</table>

Some species need overpass for wildlife (planting)

We should investigate species inhabited there!
We should select overpass type!

Asari et al. (2019) Landscape and Ecological Engineering
PART 3: DEVELOPMENT OF ANIMAL PATHWAYS

Dormice
In 1998: First ever Dormouse bridge

Length: 15.0m Height: 8.9m

The total cost: $200,000 (USD).

2007: First Animal-pathway built

Length: 13.6m

$20,000~50,000 (USD)
Video cameras were placed on both sides of the animal pathway to record how the pathway was used on a round-the-clock basis. The first dormouse crossed over 18 days after construction.
In 2011 Tochigi Prefecture.

First use: 7 hours after construction

This is the World Record!
Most Japanese arboreal animals used the pathway

Total monitoring was 2674hr. in AP1 and AP2 4518 hr. Major users are Wood mice and Dormice in both pathways.

1510 times for 2674 hours
Average 7 times used per night

378 times for 4518 hours
Average 2 times used per night
Now nine Animal-pathways in Japan.
ONE IN THE UK: IAN (PTES) WILL SPEAK

Above railroad track, The Isle of Wight, UK
CONCLUSIONS

- In Japan, there are a lot of kinds of WCSs for various species.
- Because of few WCSs for arboreal mammals, we must develop more overpass like a suspension bridge.
- We showed the structure of WCSs (Size and Openness, Presence/absence of drainage) preferred by wild mammals.
- How many WCSs should we set (the number and optimum intervals)?
- What kind of WCSs (Box, Pipe or Bridge) should we set?
ACKNOWLEDGMENTS

- We would like to thank the following people for their contributions to the development and dissemination of the Animal Pathway.
  - Koichi Otake, Kazuaki Iwamoto, Manami Iwabuchi, Haruka Aiba, Shinji Oda, Hiroyuki Komatsu, Yoshiharu Sato & Junko Sechibaru at Animal Pathway & Wildlife Association
  - Pat Morris at Former Chairman of the Mammal Society, UK.
Thank you for your attention