Applied Evolutionary Ecology Part 3: Road Ecology I

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Biol 417: Evolutionary Ecology

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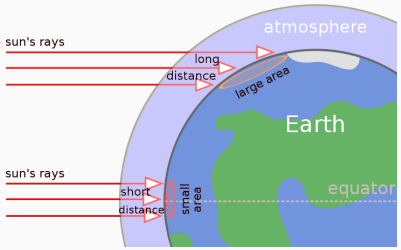
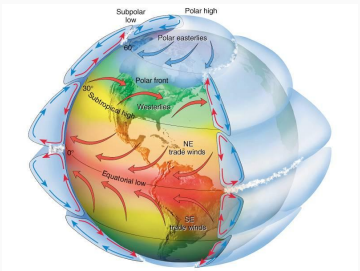
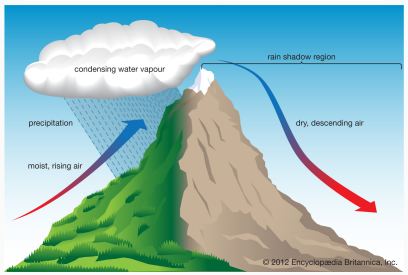
Overview

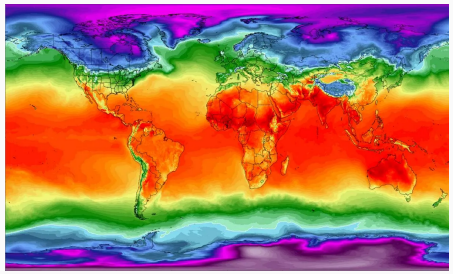
Overview

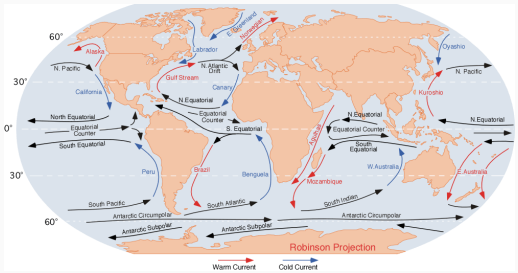
We started this course by talking about the importance of local conditions in shaping evolutionary trajectories.

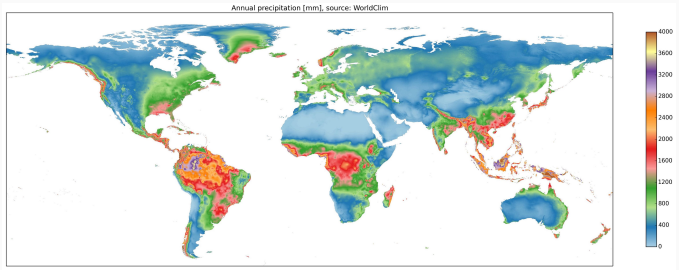






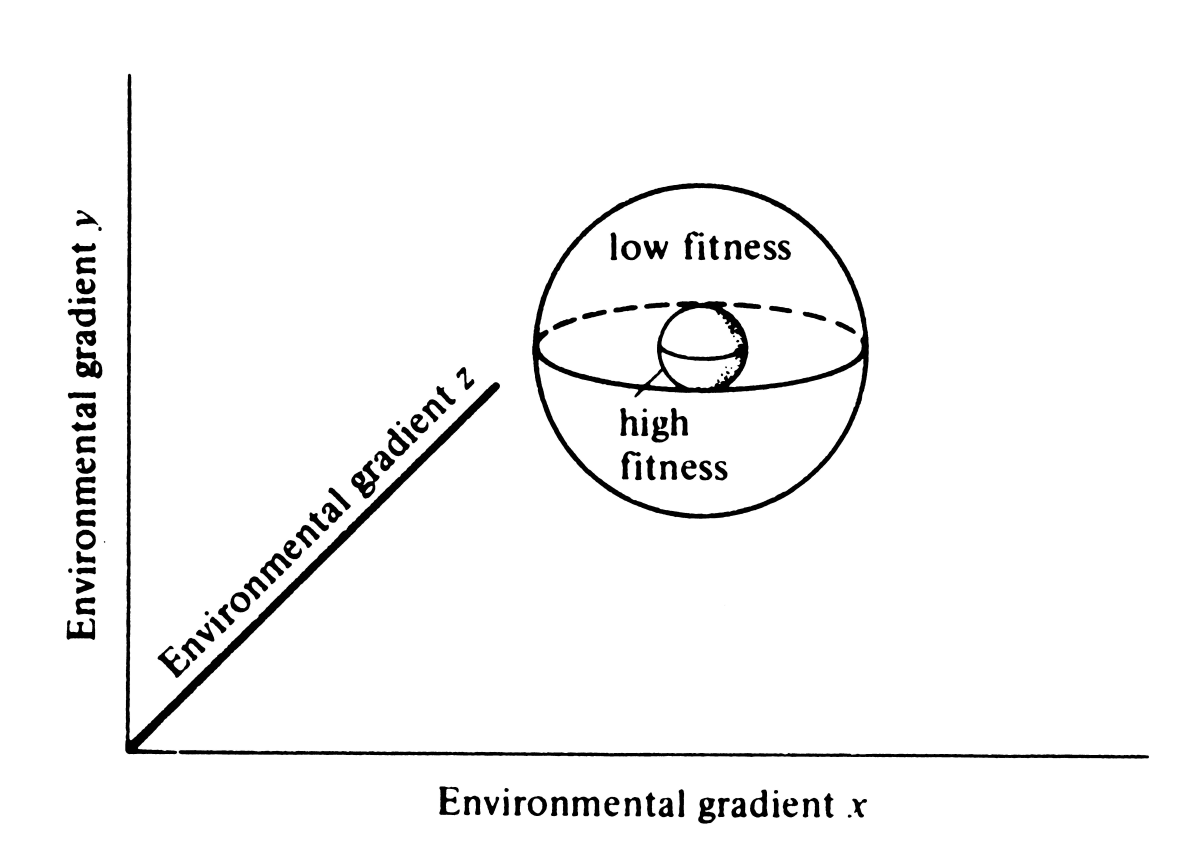






Overview cont.

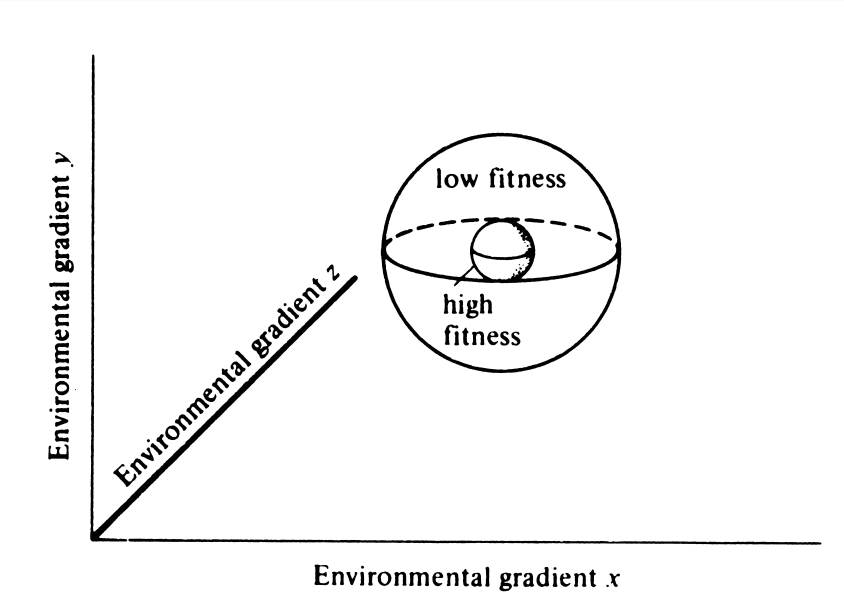
... and how a species' ecological niche reflects the outcome of many generations of interactions between individuals and the environments they live in.



Source: Pianka (2000)

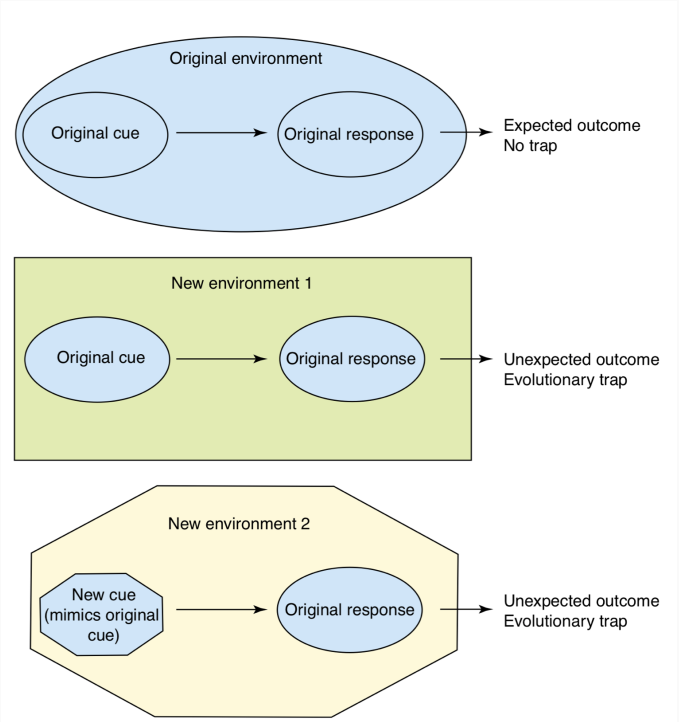
Overview cont.

Under natural conditions, this leads to adaptedness (i.e., individuals' traits are well matched to their environment)



Source: Pianka (2000)

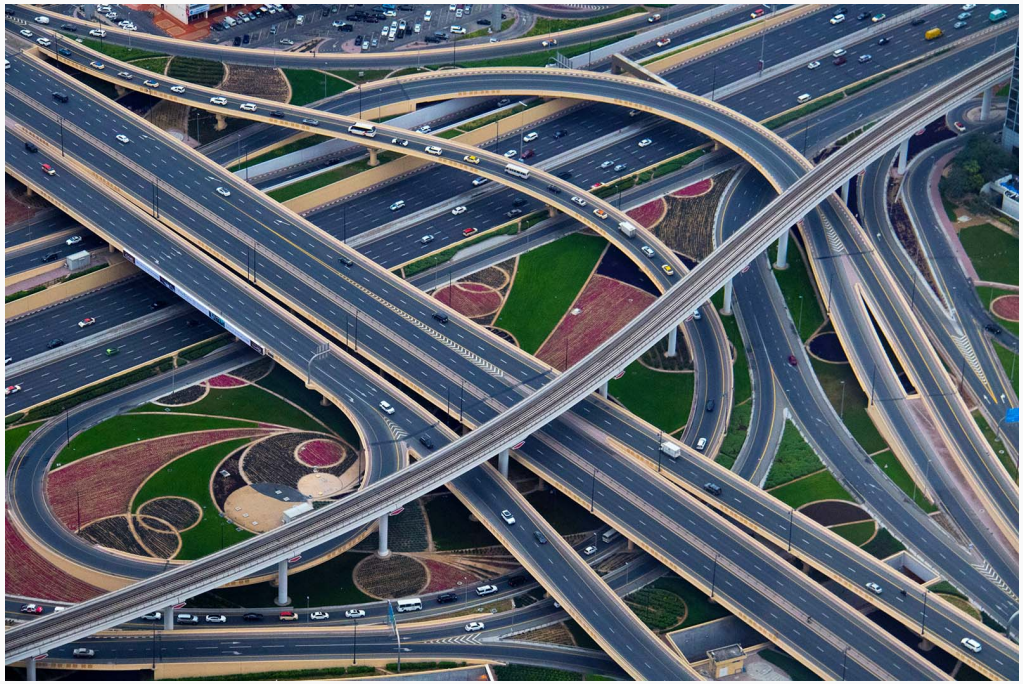
... but human activities can lead to maladaptedness (i.e., individuals' traits are no longer matched to their environment).



Schlaepfer *et al.* (2002)

Overview cont.

Many human activities can lead to disturbances, and ecological/ evolutionary traps, but one of the most impactful are roads.



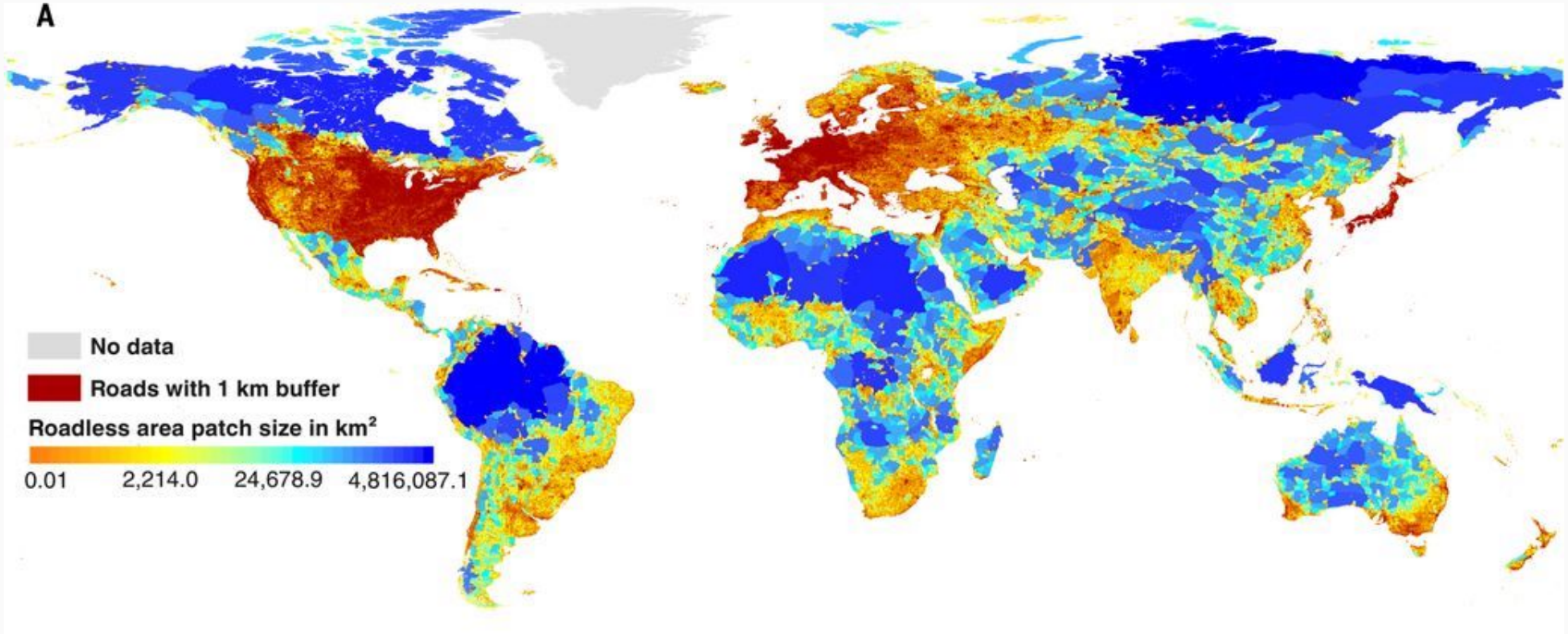
Source: Unsplash

Over the next two lectures we will explore the ecological and evolutionary impacts of roads.

Roads

Road densities

There are ca. 64,000,000 km of roads across the globe and few locations are free from the impacts of roads.



Ibisch *et al.* (2016)

Distribution

In the U.S. there are ca. 6.2 million km (Forman & Alexander, 1998).

Interstate highways represent 1%

...and 10% are in national forests.

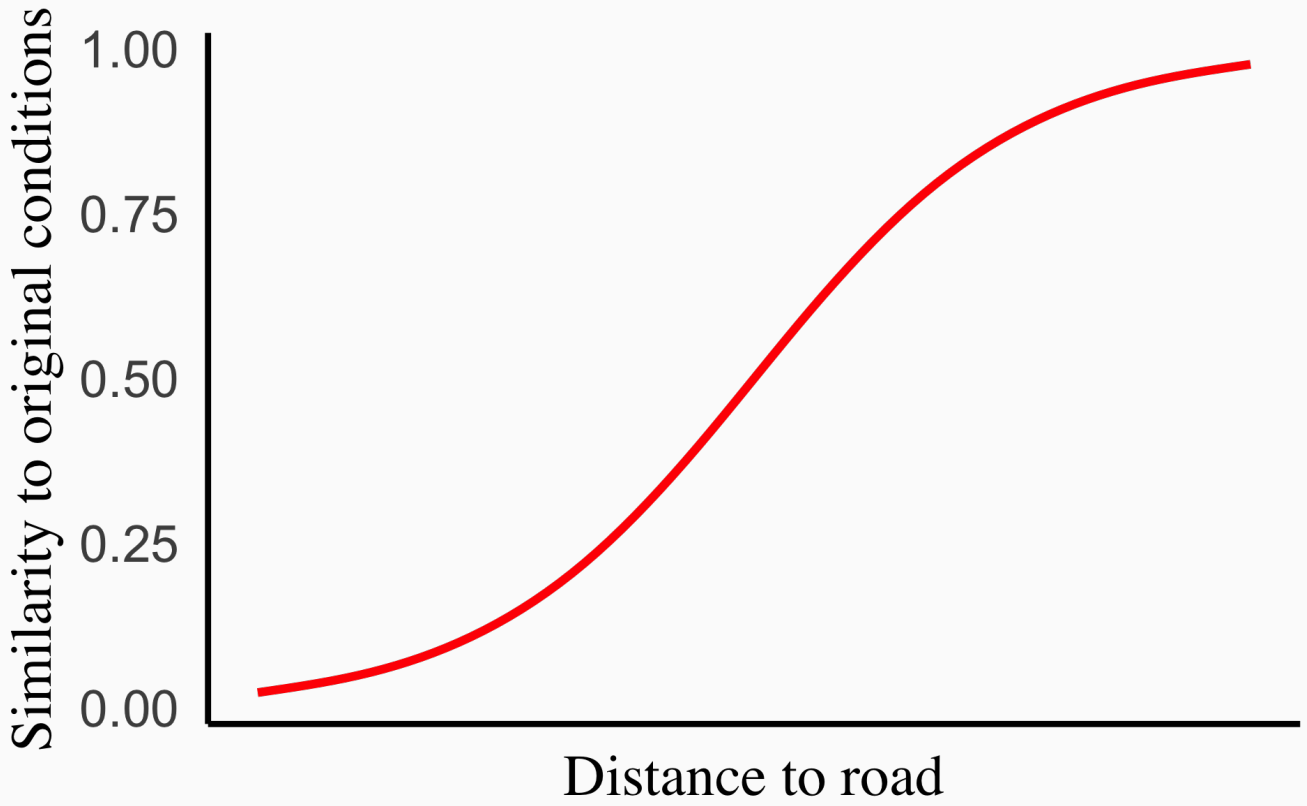
The potential ecological impacts of roads is significant.

Paved vs. Unpaved

Roads can also be paved or unpaved and we can not assume that the impacts of paved and unpaved roads will be the same.

Roadside gradient

Roads generate a gradient of conditions compared to the underlying conditions of the local environment.



Roadside Vegetation

Roadside Vegetation

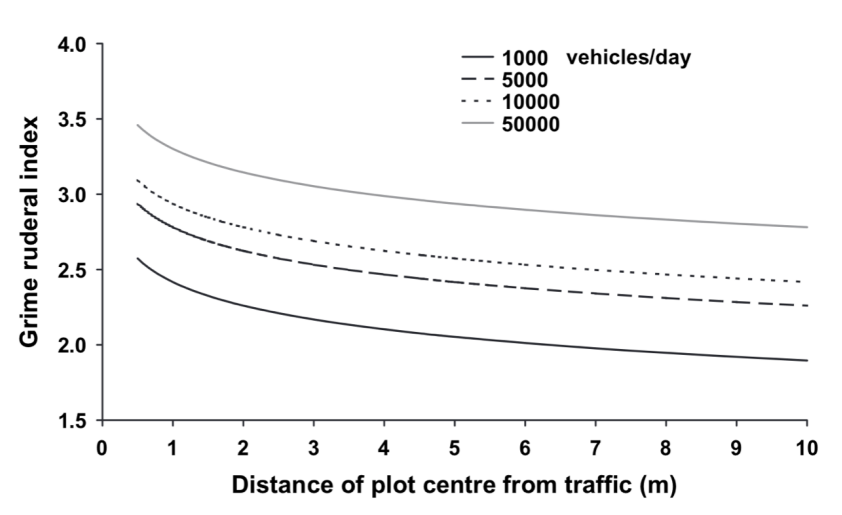
Roadsides (or verges) are high disturbance systems.

Roads also open up canopies, making verges high light systems.

Roadside composition

Truscott *et al.* (2005) studied the vegetation composition of 92 road verges in Scotland.

Competitor and stress-tolerant species were more abundant far from the verge edge



Truscott *et al.* (2005)

... whereas ruderal plant species dominated near the edge.

F. rubra

Wikipedia

P. annua

Wikipedia

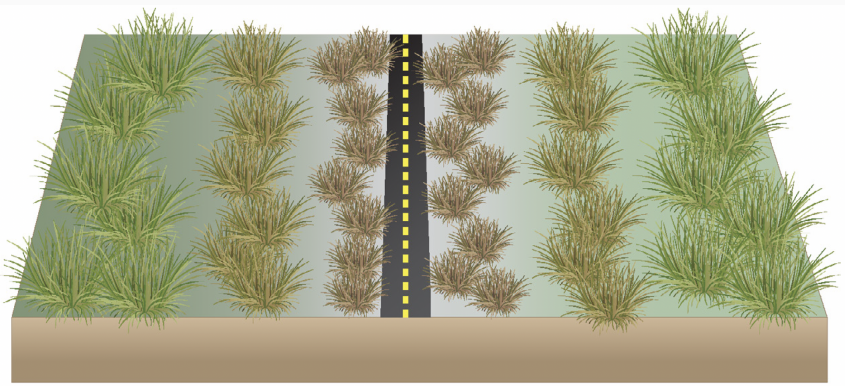
E. repens

Wikipedia

Roadside Chemistry

Road water runoff has unnaturally high concentrations of salts and metals

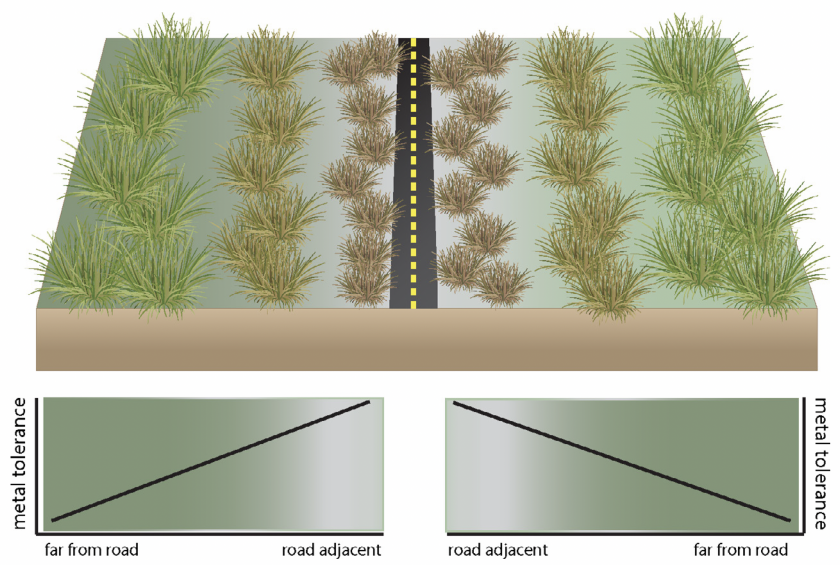
... leading to a gradient in salt and metal concentrations in roadside soil.



(Brady & Richardson, 2017)

Roadside Chemistry cont.

Roadside plants have evolved to cope with higher concentrations of lead.

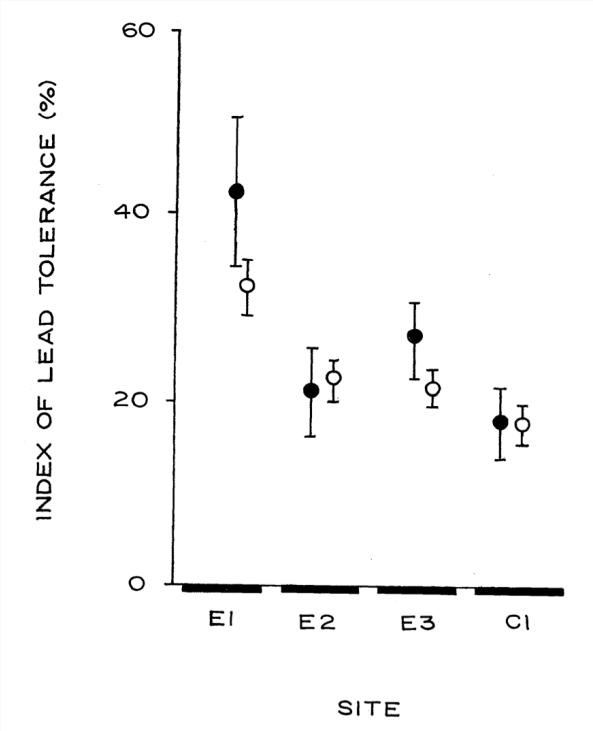


(Brady & Richardson, 2017)

Table 1 Lead Content (p.p.m.) of Roadside Plants in Central Manchester

Distance from road (m) / Species	Lead content (p.p.m. ±s.e.) 2	20
Ceratodon pupureus	320±12	185±9
Holcus lanatus	106± 5	37±2

(Briggs, 1972)



(Wu & Antonovics, 1976)

Roadside Effects

Nitrogen oxide emitted from vehicles can act as a fertilize (Angold, 1997).

Source: Wikipedia

Air turbulence can increase seed dispersal distances (Wemple *et al.*, 1996).

Source: iStock

Non-native vegetation planted to control erosion can spread to nearby systems (Forman & Deblinger, 1998).

Source: LandscapingNetwork

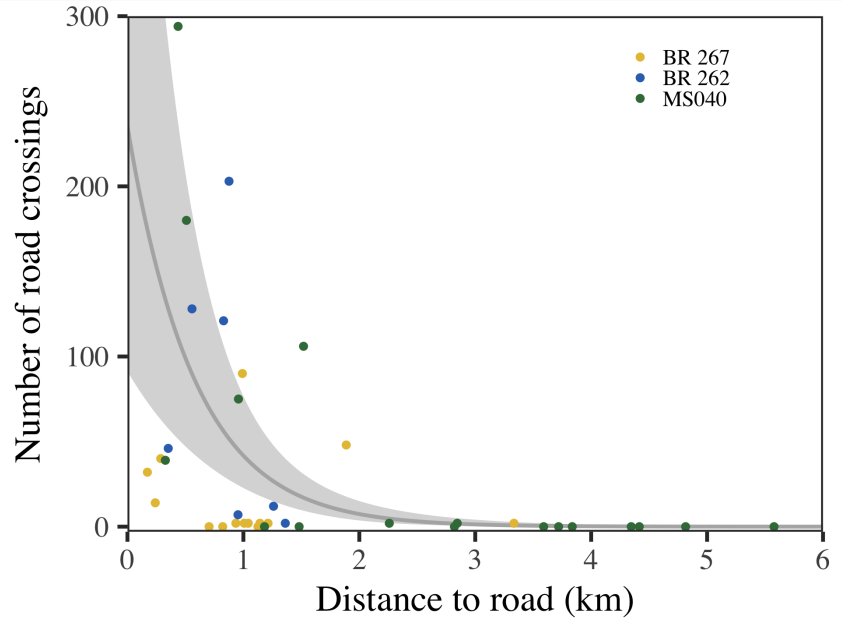
Roads and Population Dynamics

Roadkilled Animals

One of the most impactful consequences of roads on animal population dynamics is increased non-natural mortality.

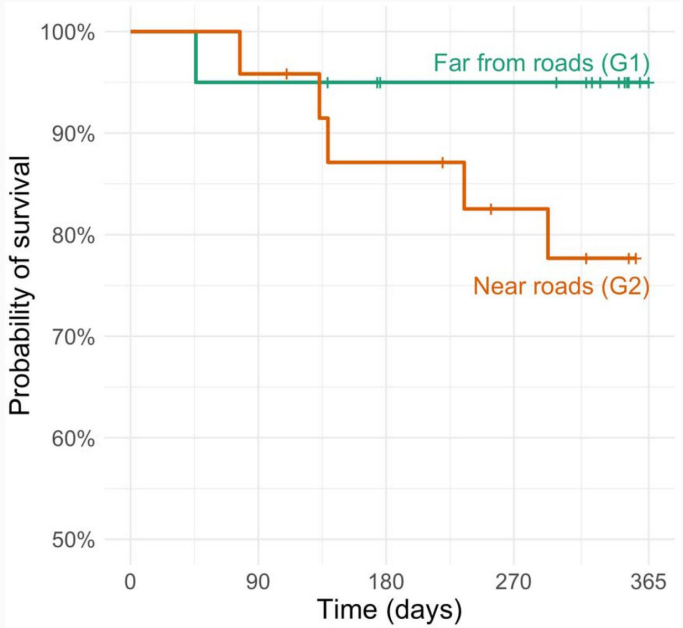
Anteater roadkill

Giant anteaters readily cross high-traffic roads.



(Noonan *et al.*, 2021)

This decreases their survival and ca. 20% of road-side populations are road-killed every year



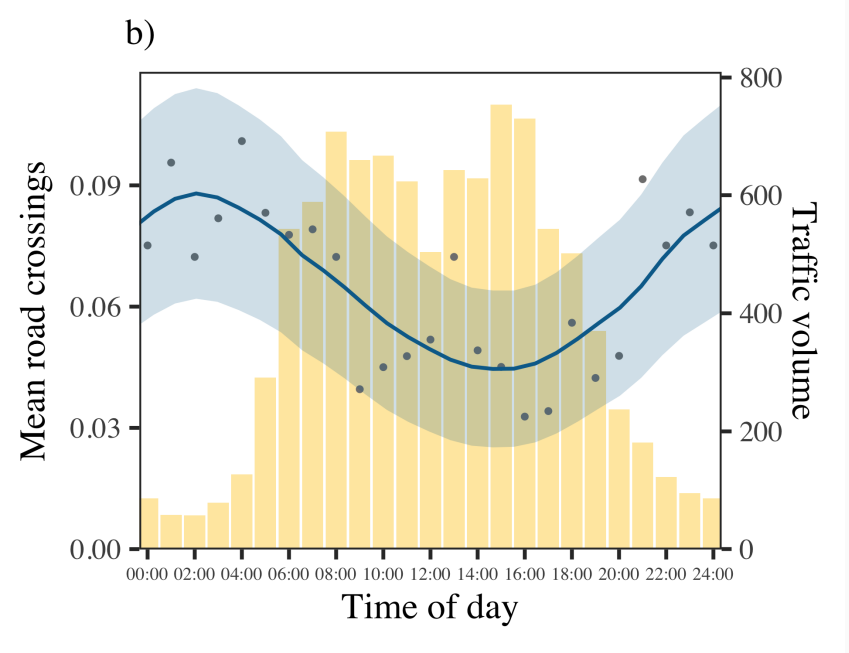
(Ascensão & Desbiez, 2022)

... reducing population growth rate by half (Desbiez *et al.*, 2020).

Anteater roadkill cont.

Giant anteaters' circadian rhythms are also highly plastic (some pops. are nocturnal, some diurnal, some crepuscular).

In roadside populations their activity is shifted towards times of low traffic volume.

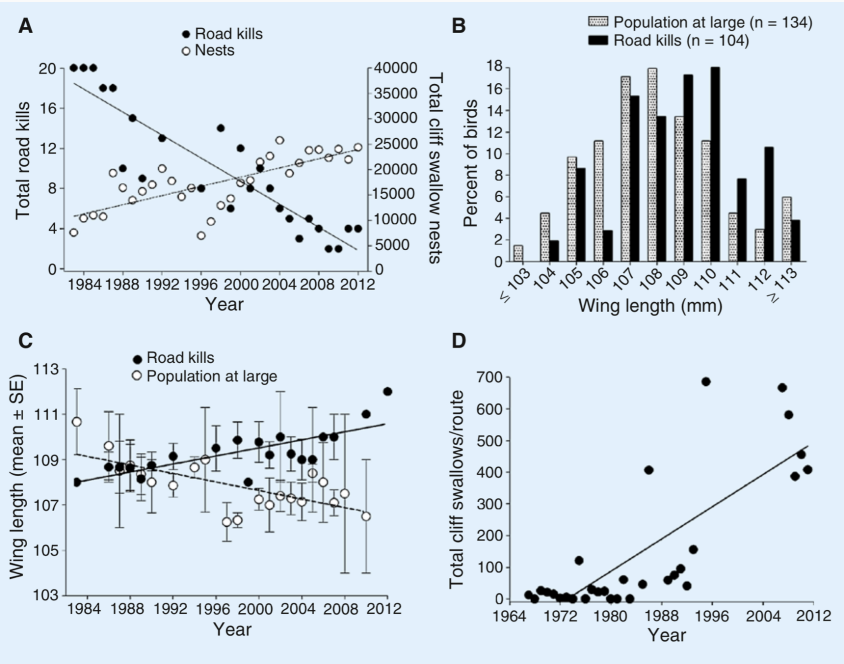


(Noonan *et al.*, 2021)

Road mortality as en evol. force

Source: eBird

Over 30 years, the number of road-kill cliff swallows (*Petrochelidon pyrrhonota*) decreased despite an increase in overall population size.



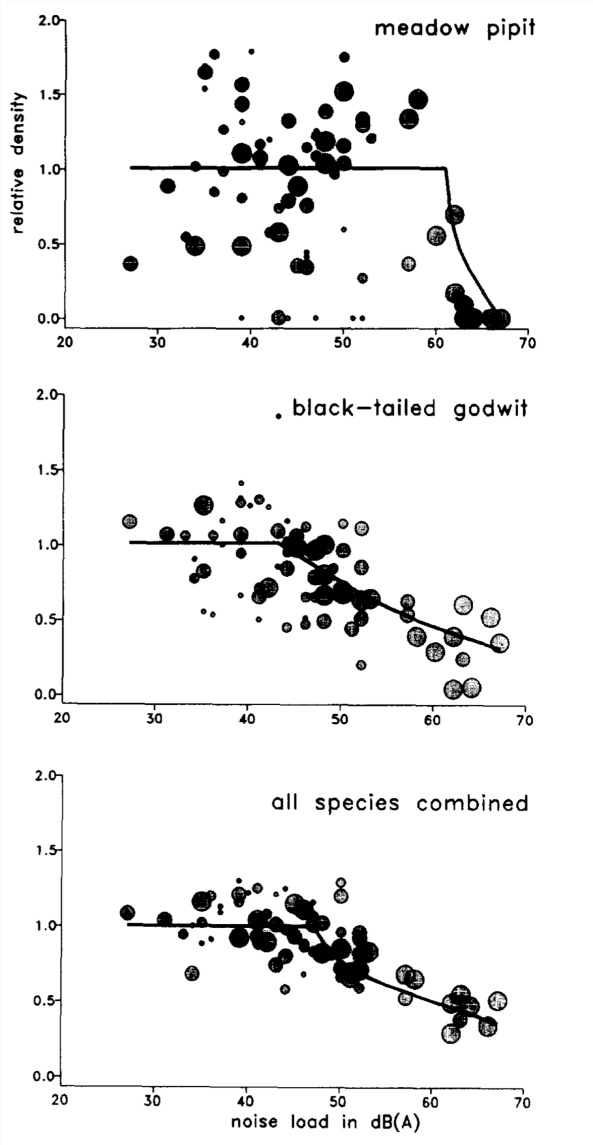
(Brown & Brown, 2013)

At the same time, wing length of road-kill swallows increased while that of the overall population decreased (i.e., selection for increased maneuverability and vertical takeoff achieved by shorter wings).

Noise and population densities

Noise pollution from traffic makes it difficult for songbirds to attract mates.

This reduces bird densities up to ca. 1 km from roads.



(Reijnen *et al.*, 1996)

Water, Sediment, Chemicals

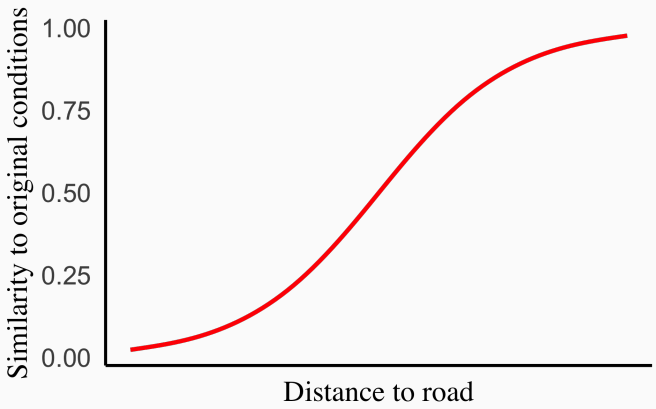
Roads alter natural water runoff patterns.

Roads are major sources of non-natural sediment deposition.

Runoff transport chemicals (salts, metals, etc.) to groundwater and stream ecosystems.

Roadside Vegetation Take Homes

Roads generate a gradient of conditions compared to the natural conditions of the local environment.



This gradient favours disturbance specialists near roads and shapes the evolution of roadside plants.

Roads can also change plant dispersal patterns.

Roadside plant communities are likely to have substantially different composition from their natural state.

Roadside Population Take Homes

Roads are a serious source of non-natural mortality.

This can reduce population viability and drive species to evolve adaptations to counter road-induced mortality.

Non-natural noise pollution around roads can cause species that rely on auditory cues to struggle in roadside environments.

Most road related impacts are tied to species no longer being adapted to their local environment.

Next lecture we will focus on the impacts of roads on animal movement.

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