

Using microphone arrays to explore communication strategies in songbirds

Talk Outline:

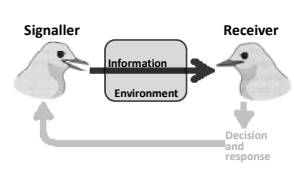
1. Communication networks in temperate chickadees
2. Vocal duetting in neotropical wrens

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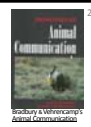


Animal Communication

- “Communication involves two individuals, a signaller and a receiver”

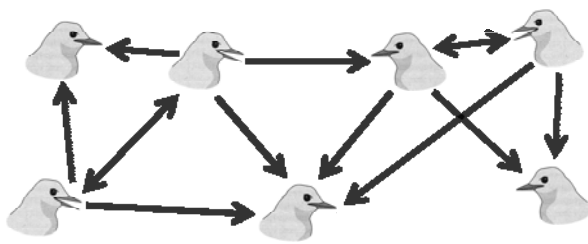



Signaller → **Information** (through **Environment**) → **Receiver** → **Decision and response**



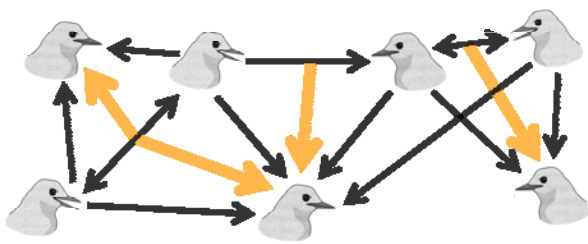
Communication Networks

- **Communication Network:** More than two individuals signalling and/or receiving simultaneously

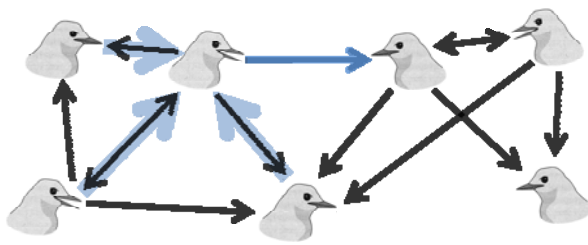
Communication Networks

- **Eavesdropping:** Gaining information by listening to a signalling interaction between others without being directly involved in that interaction



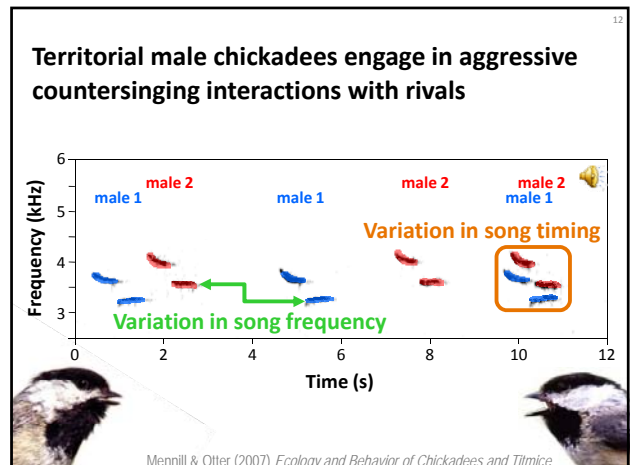
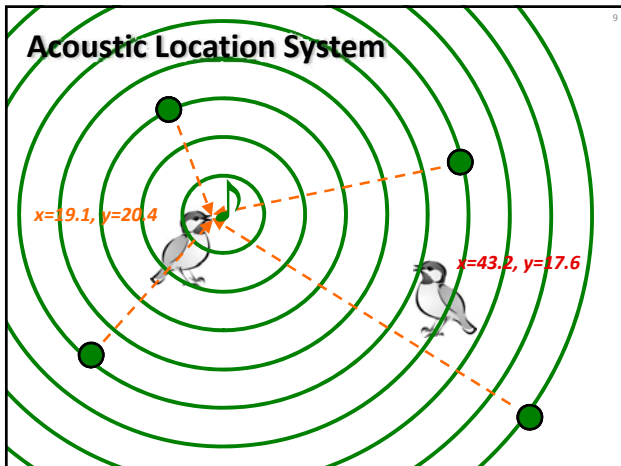
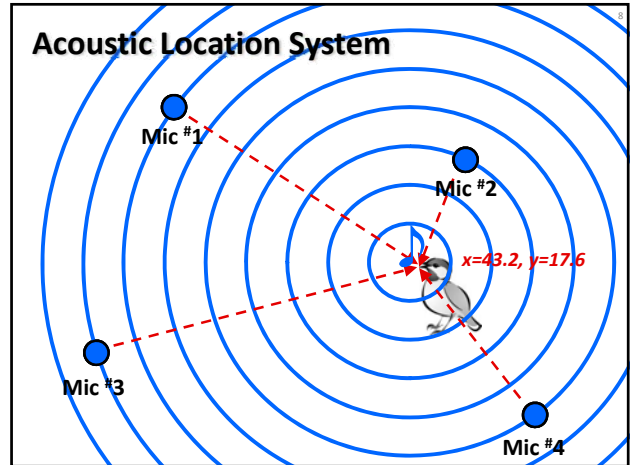
Communication Networks

- **Audience Effects:** Changes in signaller behaviour that arise from the presence of receivers




Acoustic Location System





Previous playback experiments show...



Females eavesdrop on male-male contests
Mennill et al. (2002) *Science*


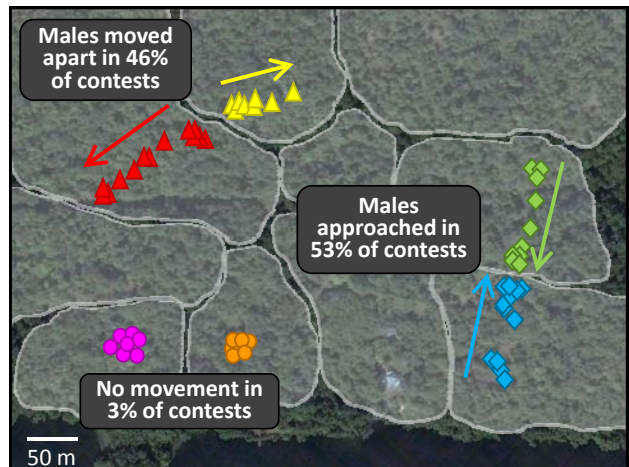
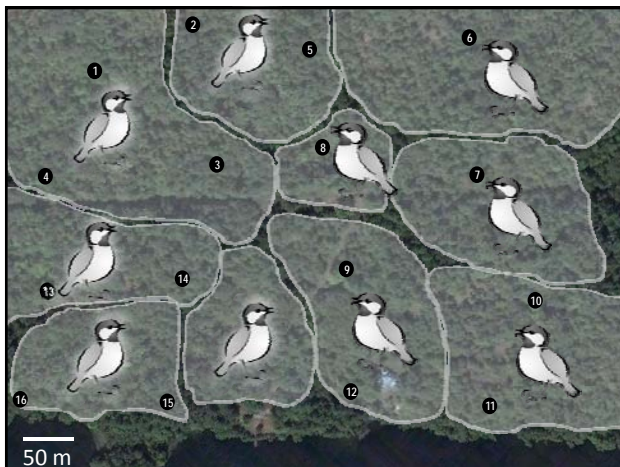
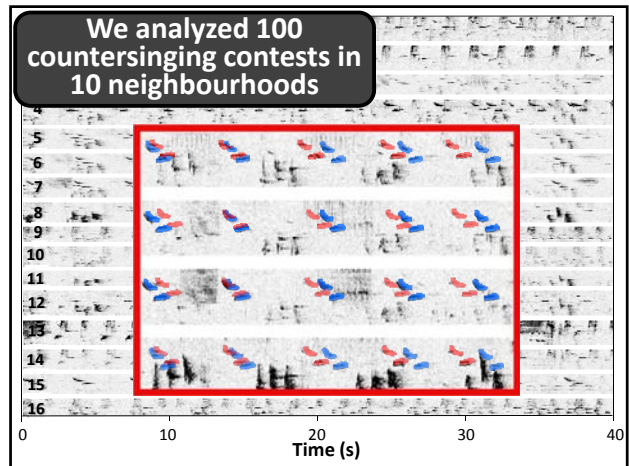
Males eavesdrop on male-male contests
Mennill & Ratcliffe (2004) *Behaviour*

...but has not been examined in a natural context.

Goals


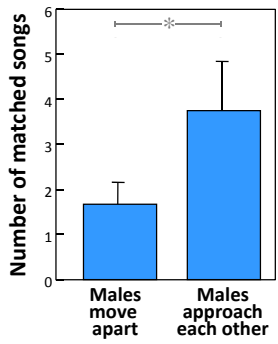
Part 1: Use an Acoustic Location System to examine countersinging and movement behaviour at a network scale

Part 2: Use multi-speaker playback to examine neighbourhood-level responses to aggressive interactions

Results of multi-channel recordings:

- Contests in which males approached each other contained more matching exchanges

Condition	Number of matched songs
Males move apart	~1.8
Males approach each other	~3.8


Fitzsimmons, Foote, Ratcliffe, Mennill (2008) *Animal Behaviour*

Multi-speaker Playback

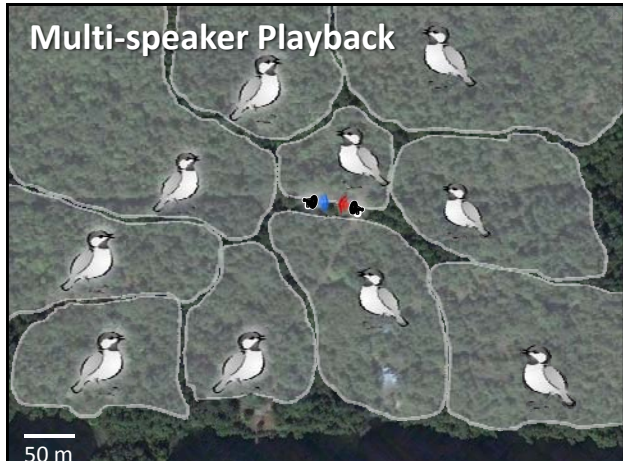


Playback simulates a song contest between two rival males

Multi-speaker Playback




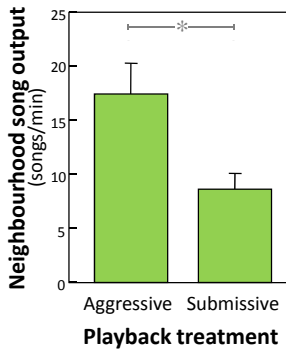
Multi-speaker Playback



50 m

Results of multi-speaker playback:

- Song output from all males in neighbourhood was significantly higher after aggressive playback
- Strong evidence for social eavesdropping





Playback treatment	Neighbourhood song output (songs/min)
Aggressive	~18
Submissive	~9

Fitzsimmons, Foote, Ratcliffe, Mennill (2008) *Animal Behaviour*

Conclusions from chickadee array recordings

- Song matching appears to function as a conventional signal of aggression; birds approach matching rivals
- Territorial males eavesdrop on interactions that take place beyond territory boundaries
- Dyadic interactions have a ripple effect throughout neighbourhoods



Further reading on chickadee networks ²⁵

- Fitzsimmons, Foote, Ratcliffe, Mennill (2008) *Frequency matching, overlapping and movement behaviour in diurnal countersinging interactions of black-capped chickadees*. *Animal Behaviour* 75:1913-1920.
- Fitzsimmons, Foote, Ratcliffe, Mennill (2008) *Eavesdropping and communication networks revealed through playback and an acoustic location system*. *Behavioral Ecology* 19:824-829.
- Foote, Fitzsimmons, Mennill, Ratcliffe (2008) *Male chickadees match neighbours interactively at dawn: support for the social dynamics hypothesis*. *Behavioral Ecology* (online first).
- Foote, Fitzsimmons, Mennill, Ratcliffe (2008) *Tied to the nest: Male black-capped chickadees decrease dawn chorus movement behaviour when their mate is fertile*. *Animal Behaviour* 76:1227-1233.



Rufous-and-white Wren (*Thryothorus rufus*) ²⁶



Bird songs are complex vocalizations produced by males during the breeding season. They play an important role in territory defense and mate attraction.

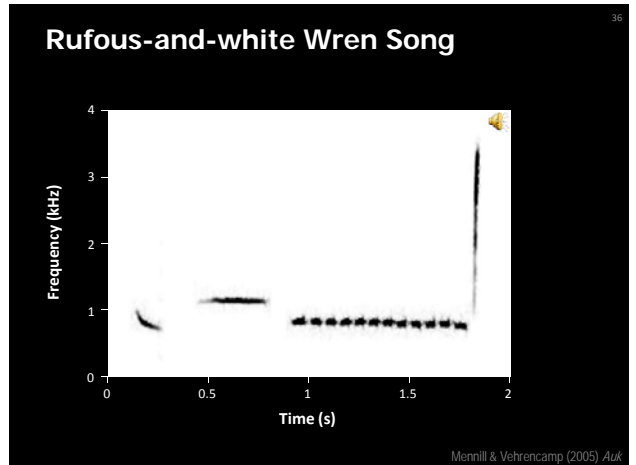


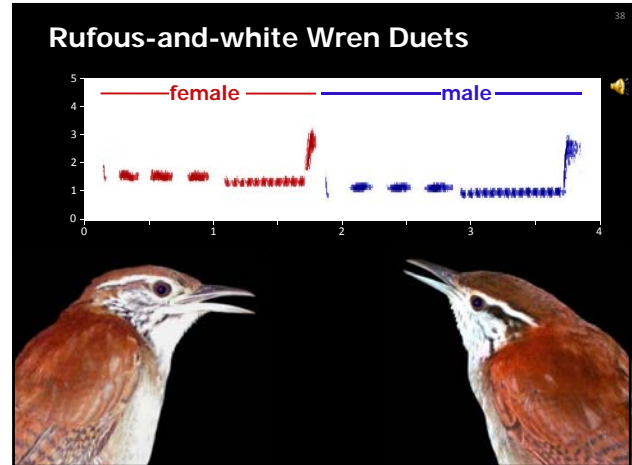
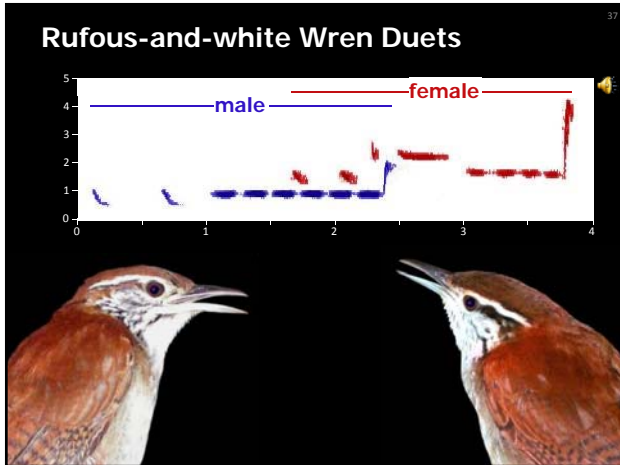
Duets: Complex, coordinated vocalizations produced jointly by members of a mated pair ²⁸



Rufous-and-white Wren (*Thryothorus rufus*) ²⁹



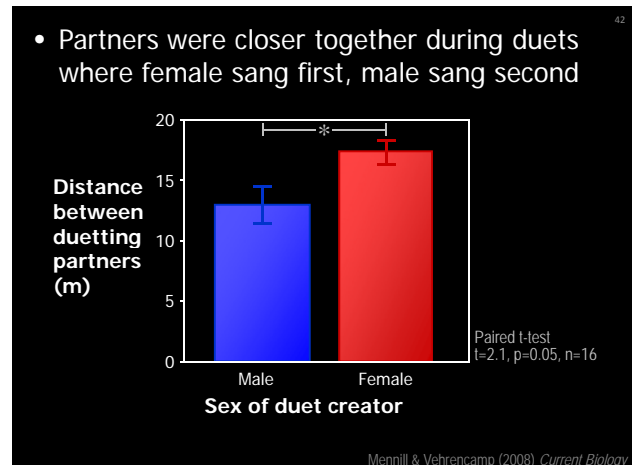
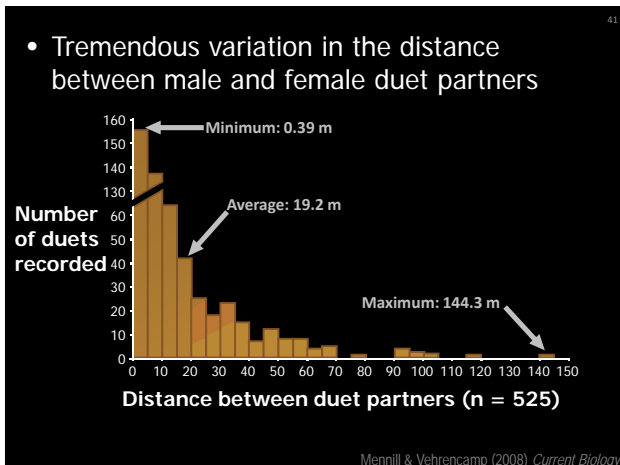
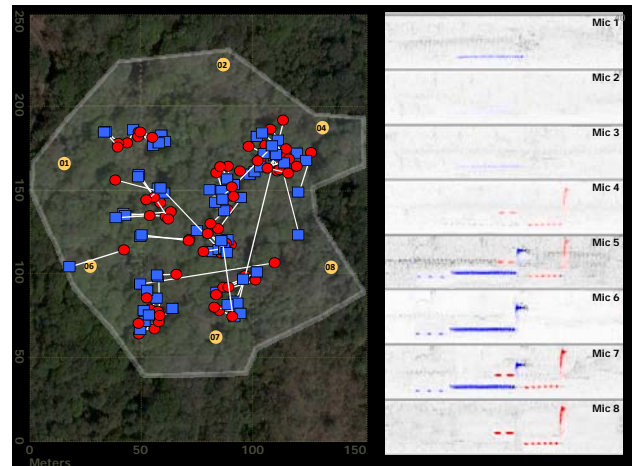




Spatial Analysis of Duetting

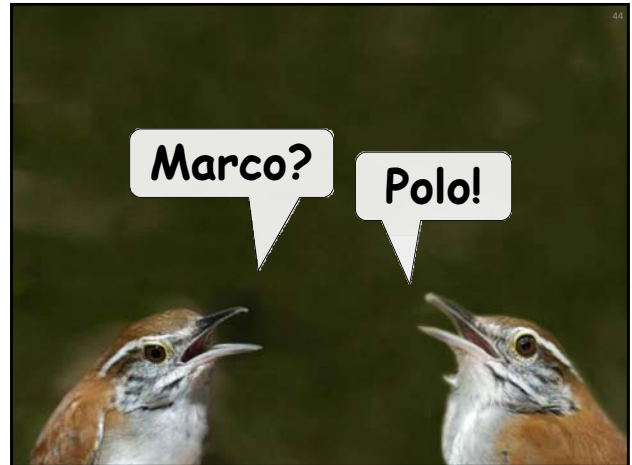
- Recorded 19 colour-banded pairs of rufous-and-white wrens with an eight-microphone acoustic location system during the early breeding season

Mennill & Vehrencamp (2008) *Current Biology*



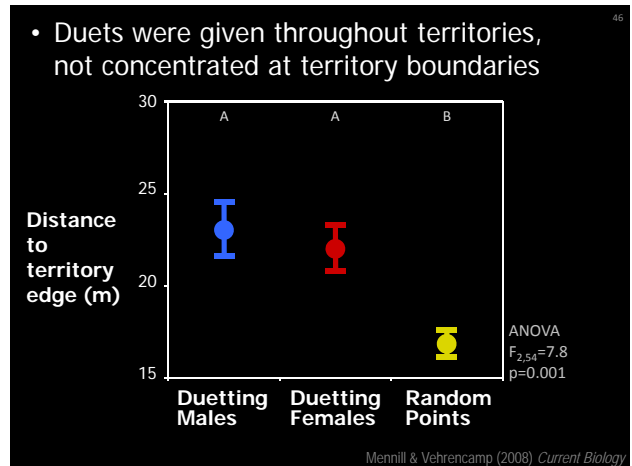
- Duets were sometimes given in bouts where pairs sang several duets in a row
- During a significant majority of these bouts (44 out of 64) the male and female moved closer together between subsequent duets
(Binomial test: $p=0.01$)

Mennill & Vehrencamp (2008) *Current Biology*



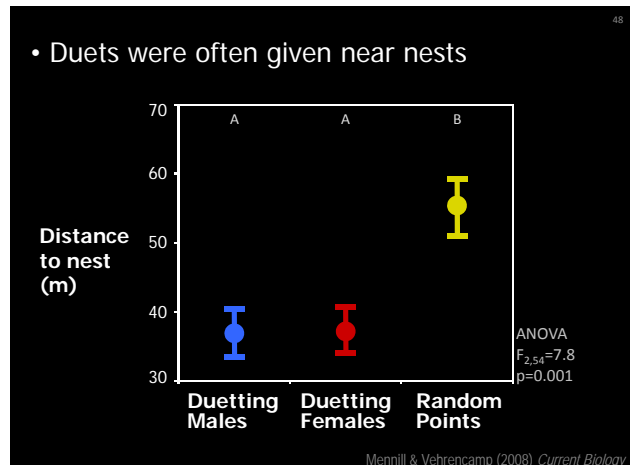
- Duets were given throughout territories, not concentrated at territory boundaries

Mennill & Vehrencamp (2008) *Current Biology*



- Duets were often given near nests

Mennill & Vehrencamp (2008) *Current Biology*



Conclusions from wren array recordings

- Duetting behaviour is consistent with the acoustic contact hypothesis
 - Birds duet when they are physically separated, often by great distances
 - Duets are not focused at territory boundaries
 - Birds approach each other during duet bouts



Further reading on wren duets

- Mennill, Vehrencamp (2008) *Context-dependent functions of avian duets revealed through microphone array recordings and multi-speaker playback.* *Current Biology* 18:1314-1319
- Topp, Mennill (2008) *Seasonal variation in the duetting of rufous-and-white wrens.* *Behavioral Ecology & Sociobiology* 62:1107-1117.
- Mennill (2006) *Aggressive responses of male and female rufous-and-white wrens to stereo duet playback.* *Animal Behaviour* 17:219-226.
- Mennill, Burt, Fristrup, Vehrencamp (2006) *Accuracy of an acoustic location system for monitoring the position of duetting tropical songbirds.* *Journal of the Acoustical Society of America* 119:2832-2839.



Using microphone arrays to explore communication strategies in songbirds

Conclusions:

- Microphone array recordings enhance our understanding of animal communication
- They facilitate monitoring at a neighbourhood scale
- They facilitate monitoring behaviour in visually-obstructed environments

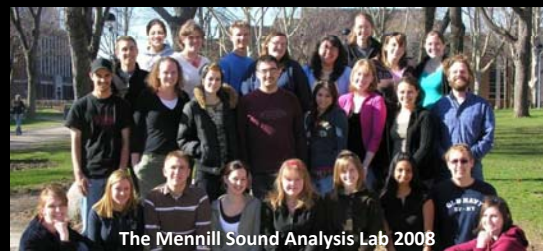


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The Mennill Sound Analysis Lab 2008

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