

Social Structure and Genetic Relatedness of Sperm Whales in the Gulf of Mexico

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Social Structure

- Interactions between individuals are the basic element of social structure.
- Relationships between individuals are determined by content, quality, and temporal pattern of interactions between them.
- Social structure of a population is determined by content, quality, and temporal pattern of relationships between individuals.

Studying Social Structure of Sperm Whales

- Interactions between sperm whales are difficult to observe due to their habitat preferences (deep water usually away from shore), as well as their diving and movement patterns.
- Previous analyses in other regions are based on associations.

What Is an “Association”?

“Identification of pairs of known individuals in circumstances in which interaction between them is likely to occur.”

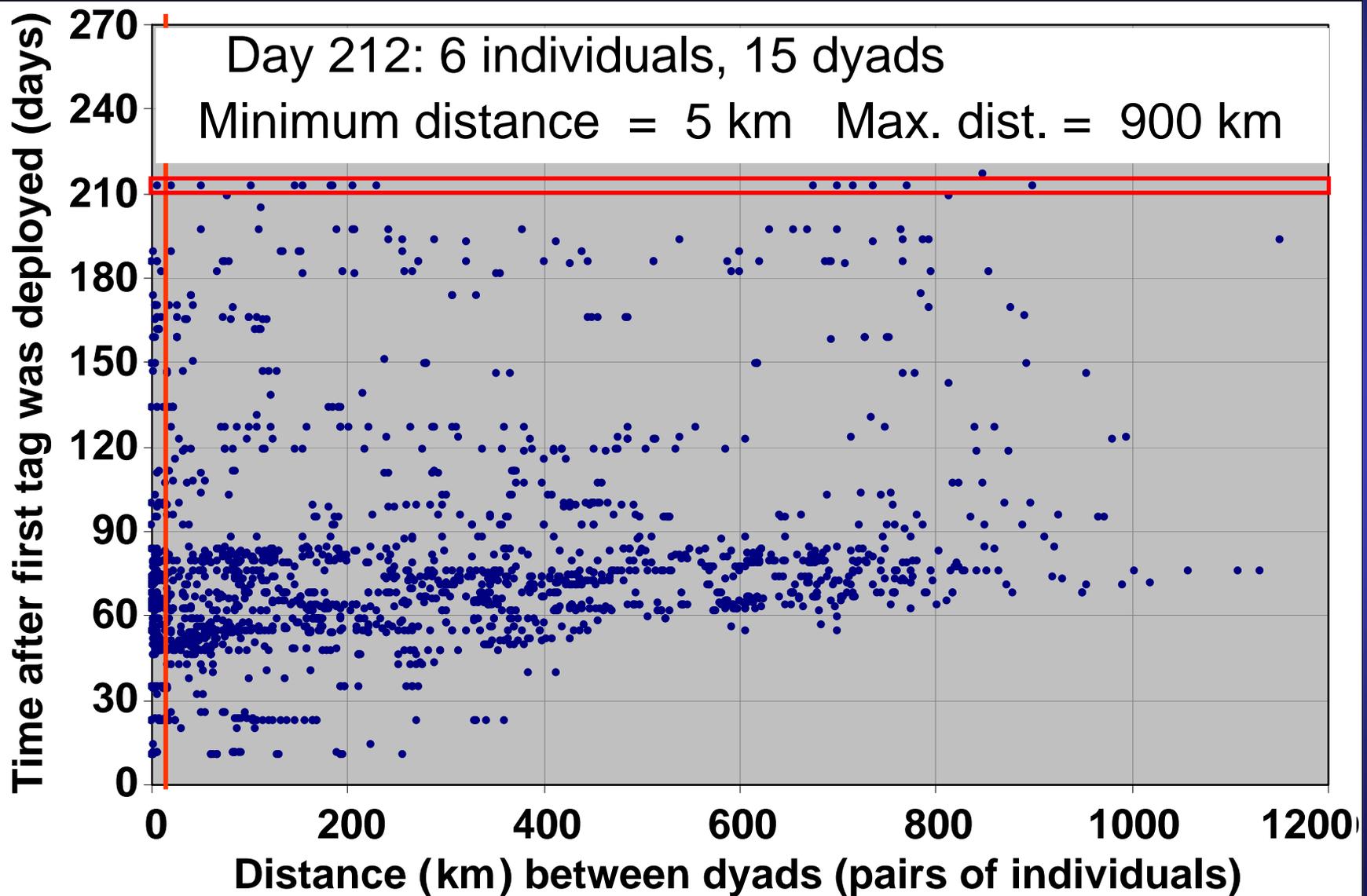
(Whitehead & Arnbom 1987)

Association of Sperm Whales

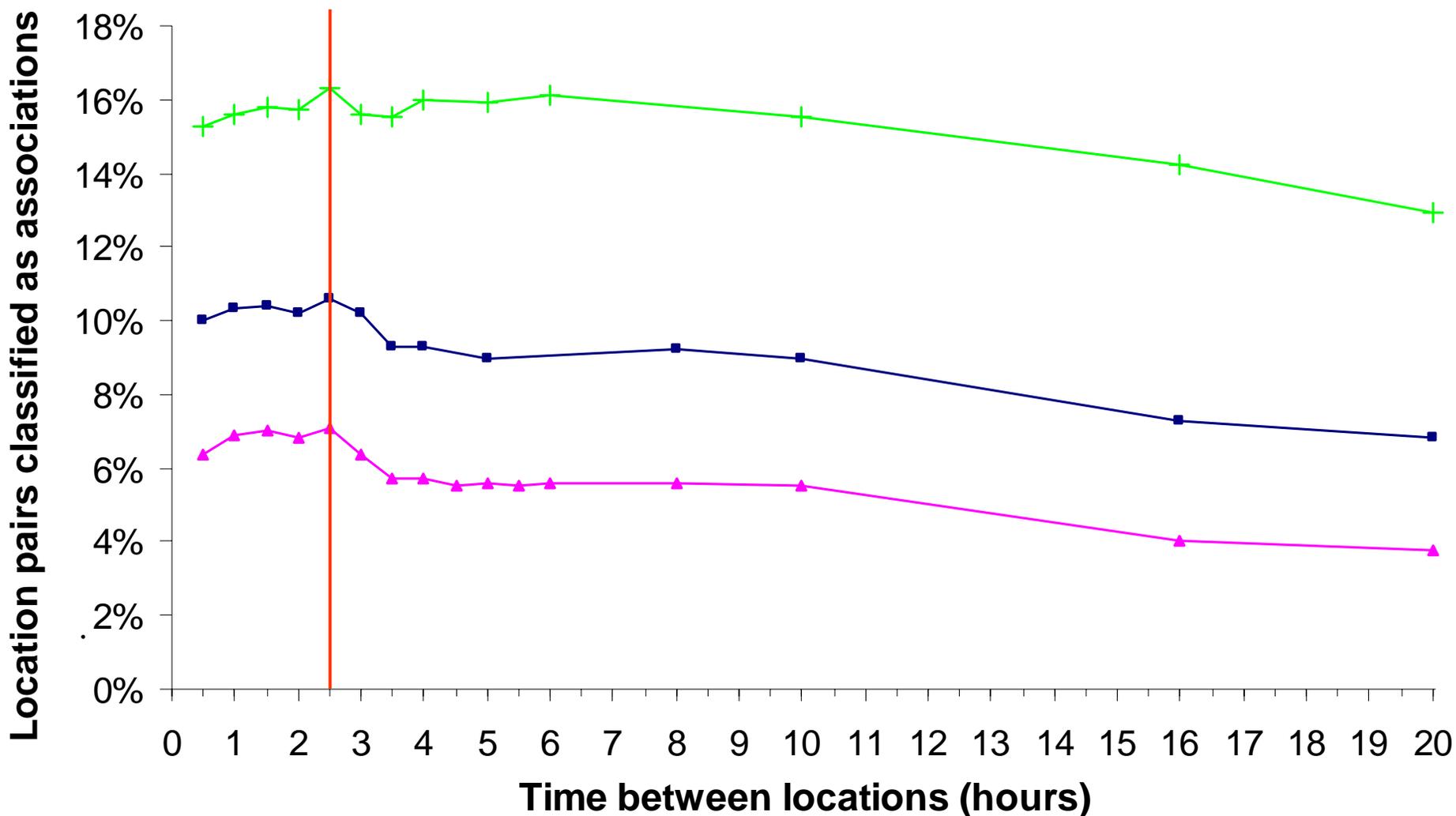
- Individual sperm whales are identified through natural marks on their flukes (photo-ID)
- Two individuals are considered associated if they were photo-identified together.

Can we use S-tag data to determine associations between individuals?

Distance Between Whales Tagged in 2002

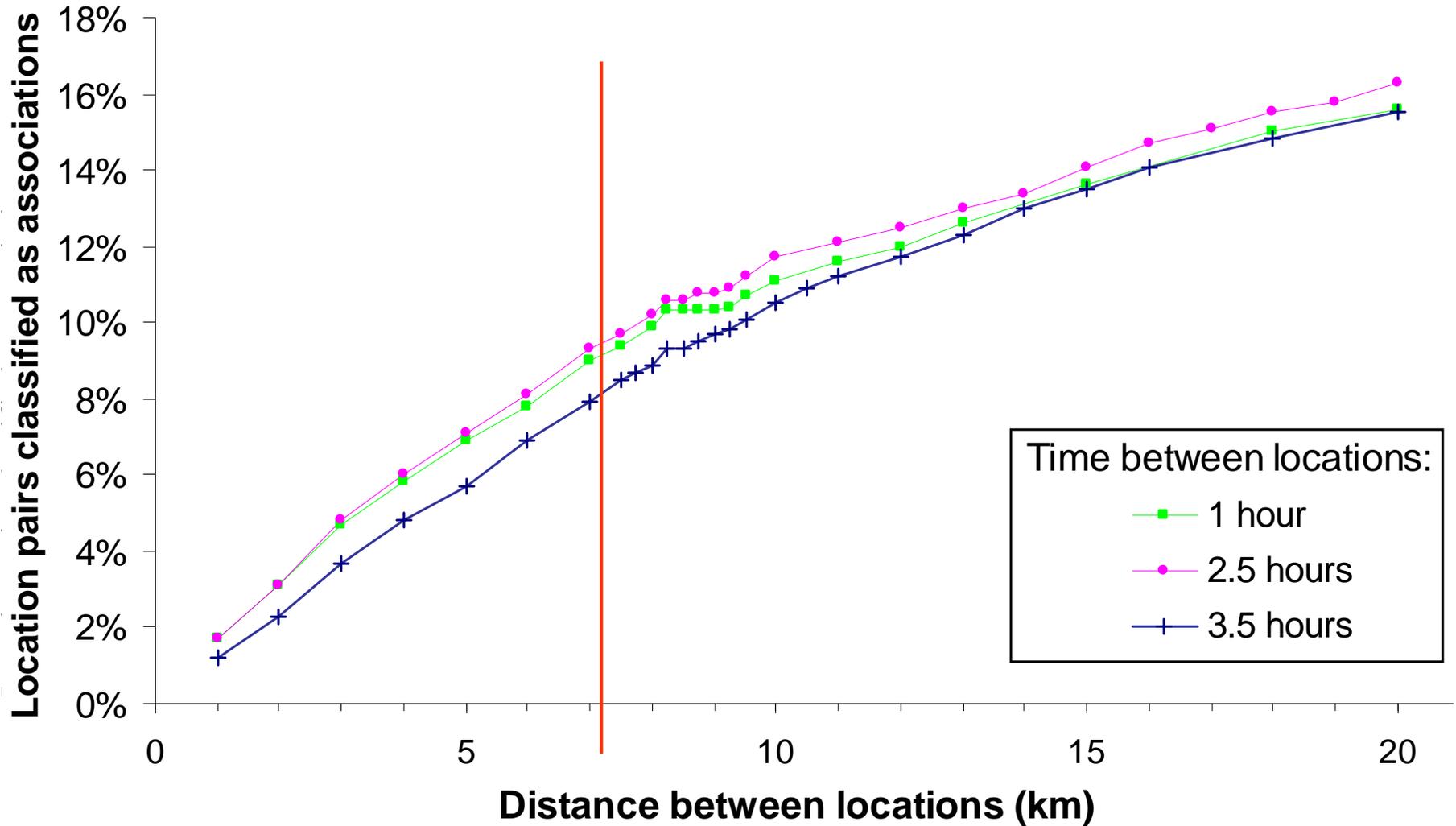


Criteria to Define Association: Time



Distance between locations: —+— 20 km —■— 8.5 km —▲— 5 km

Criteria to Define Association: Distance



Association Criterion

- Only “contemporary” transmissions (i.e. transmissions within 2.5 hours of each other) were used for association analysis.
- Two whales were considered associated if the distance between their contemporary transmissions was < 8.3 km.

Data Set Description

- Location data from 51 sperm whales tagged on SWSS cruises: 2002 (18), 2002 (15), 2003 (6), 2005 (12)
- 1688 satellite-determined, contemporary locations
- Contemporary locations grouped by day
- 295 days with 2 or more contemporary locations
- Only one pair of locations for each pair of whales retained per day (dyad-event)
- 3642 dyad-events (distance estimations)
- 402 association events (11% of all dyad-events)

Analysis of Social Structure

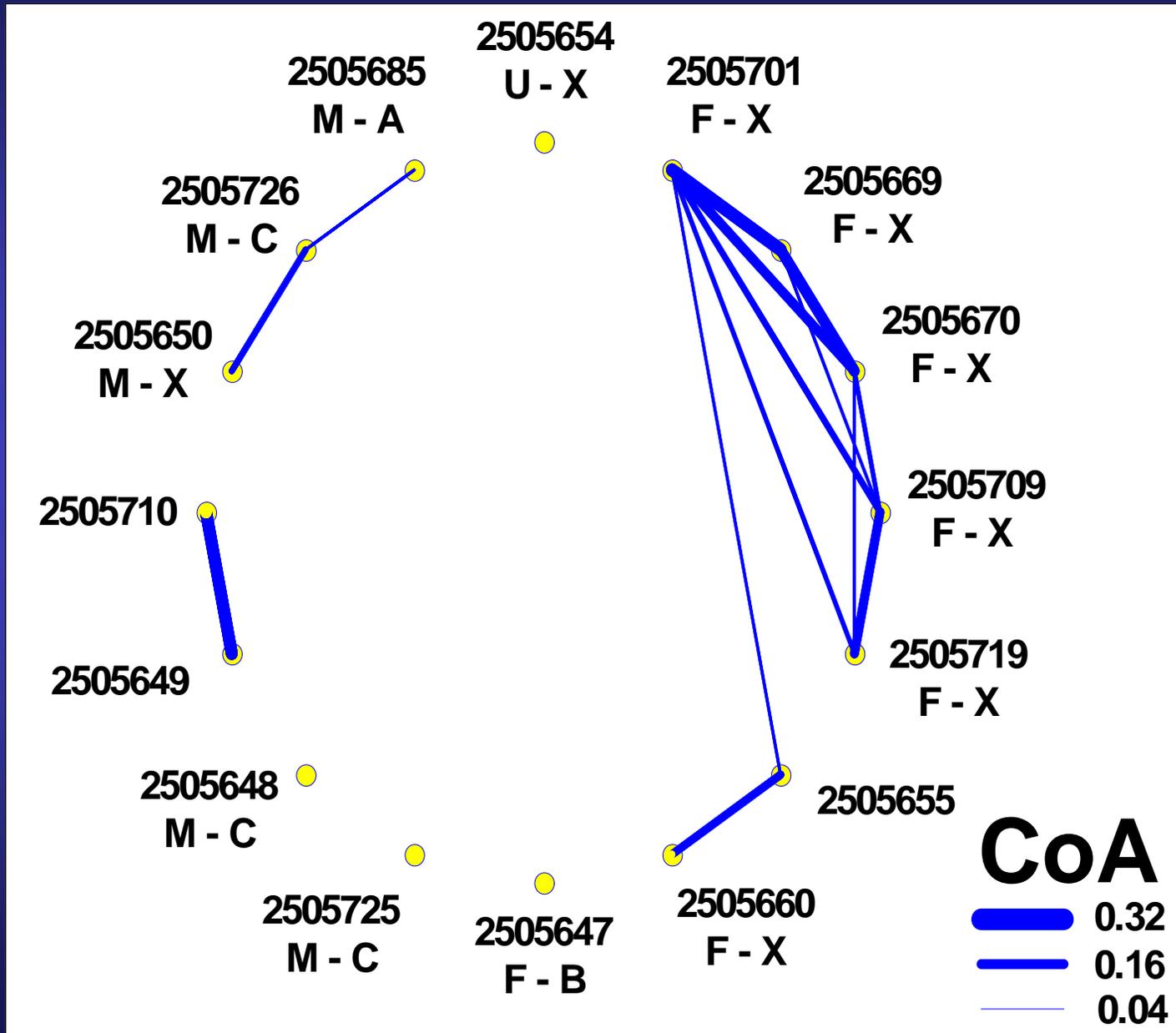
- Simple-ratio association index
(Cairns & Schwager 1987. *Animal Behaviour* 35: 1454–1469)
- Coefficient of association (CoA) estimated for all pairs of individuals tagged within the same year
- Only individuals with >10 dyad-events included in analyses
- Not enough location data for whales tagged in 2004

Genetic Analysis

(Engelhaupt 2004)

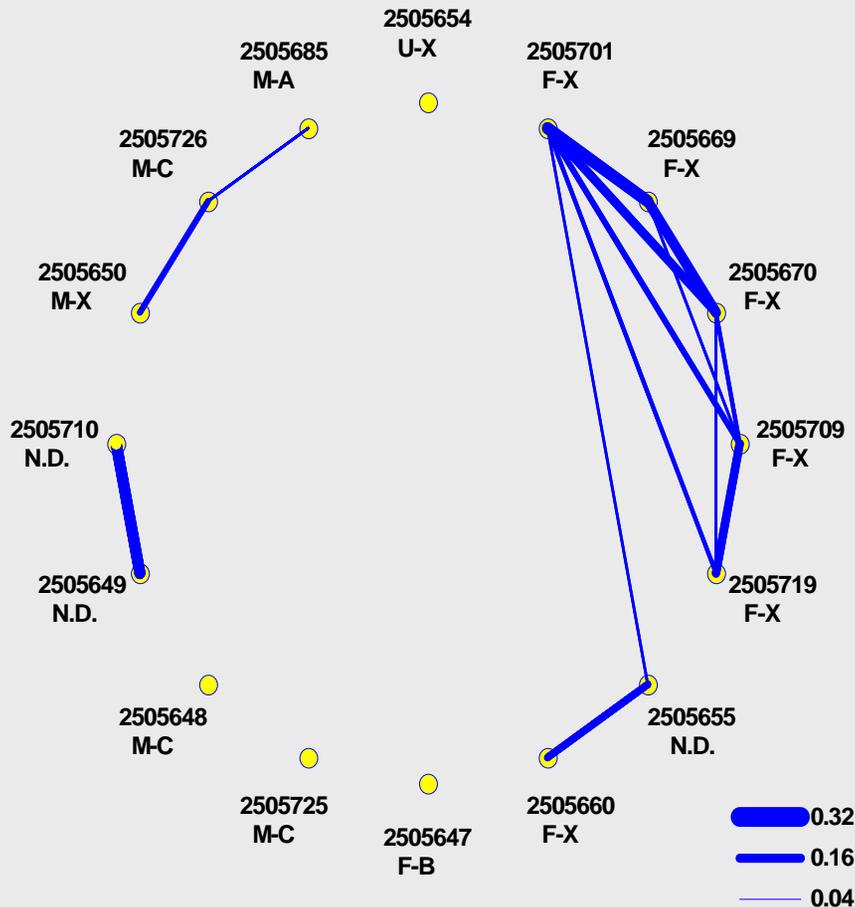
- Skin samples collected from 41 out of 51 tagged whales
- 13 polymorphic microsatellites from the biparentally inherited nuclear DNA
- 399 base-pair sequence of the maternally inherited mitochondrial DNA control region
- Sex-linked markers to determine sex
- Pairwise relatedness statistic R_{ST} (Slatkin 1995; Goodman 1997)

Sociogram for Whales Tagged in 2002

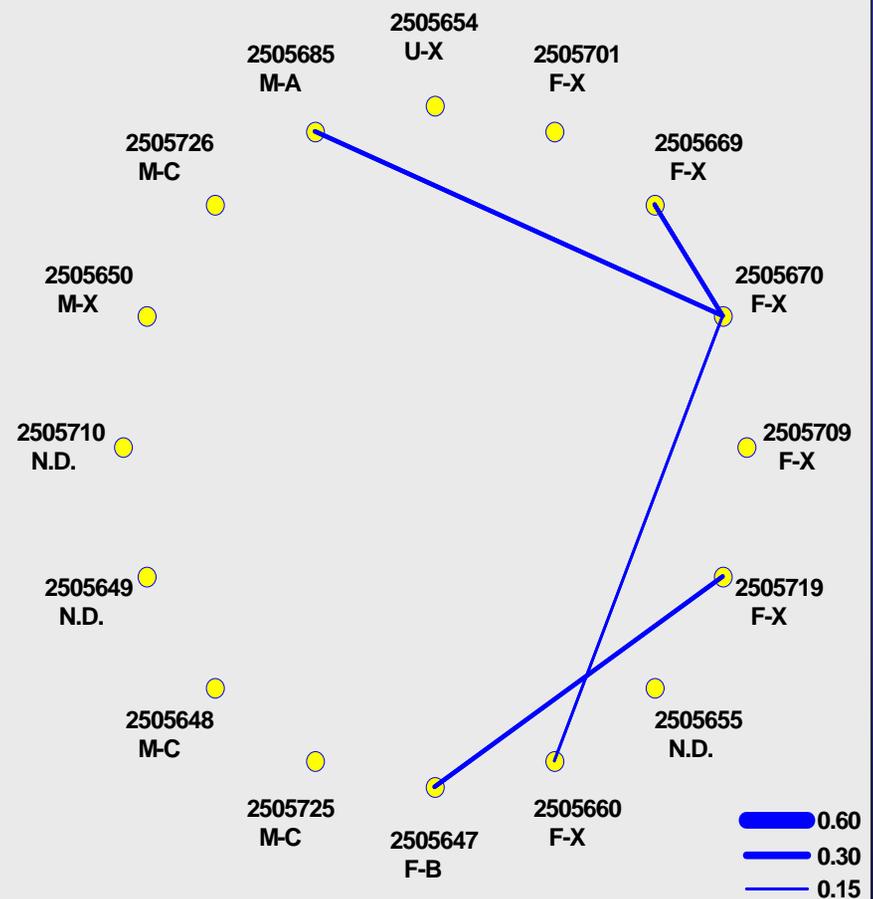


Comparison of Genetics and Social Structure for Whales Tagged in 2002

Coefficient of Association

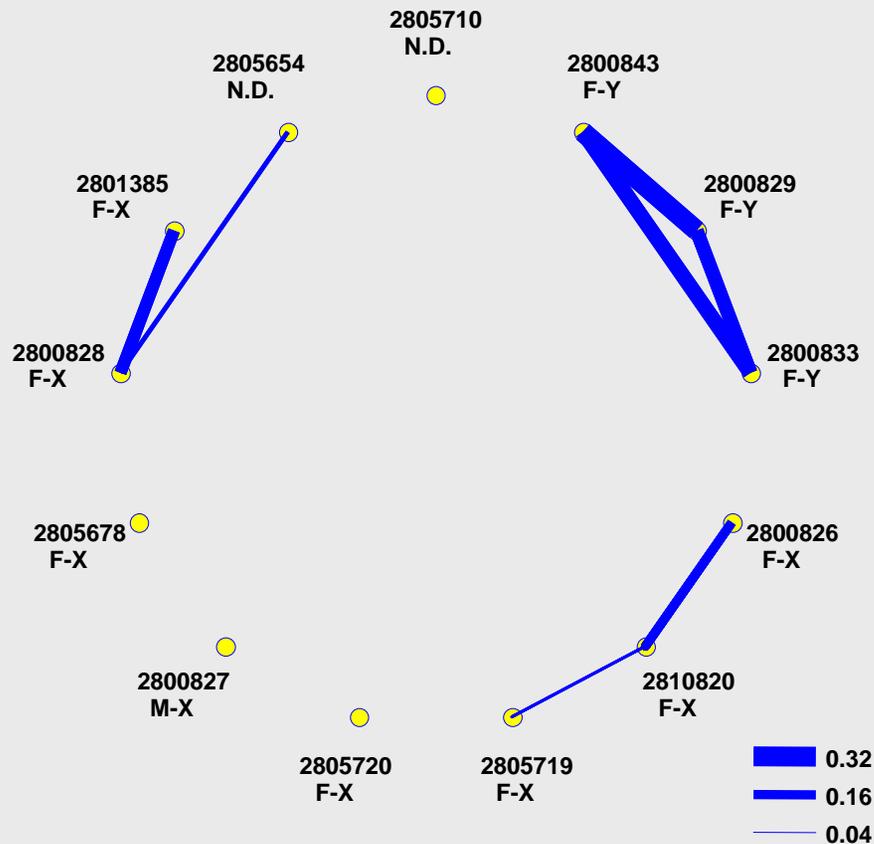


Genetic Relatedness

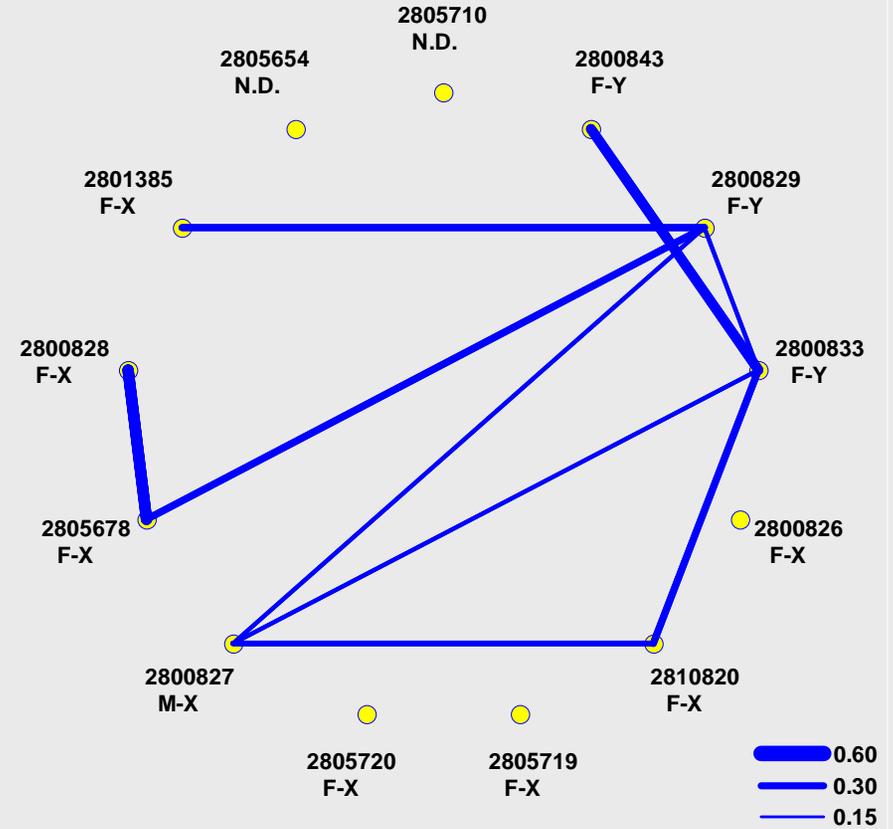


Comparison of Genetics and Social Structure for Whales Tagged in 2003

Coefficient of Association

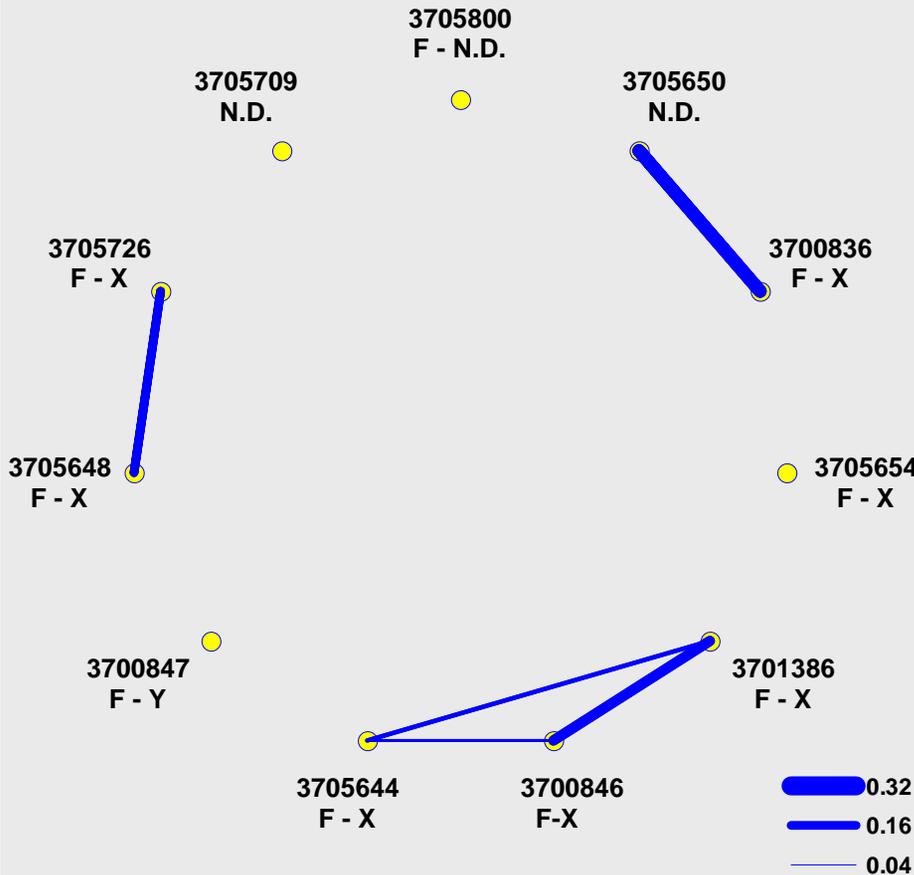


Genetic Relatedness

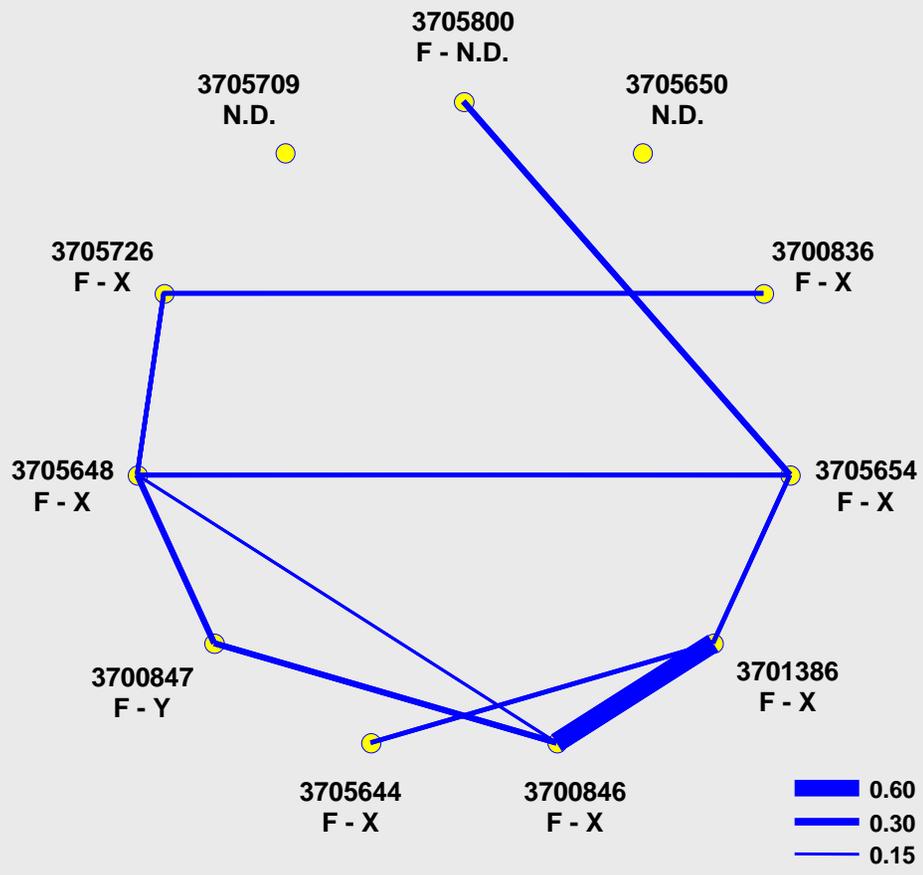


Comparison of Genetics and Social Structure for Whales Tagged in 2005

Coefficient of Association



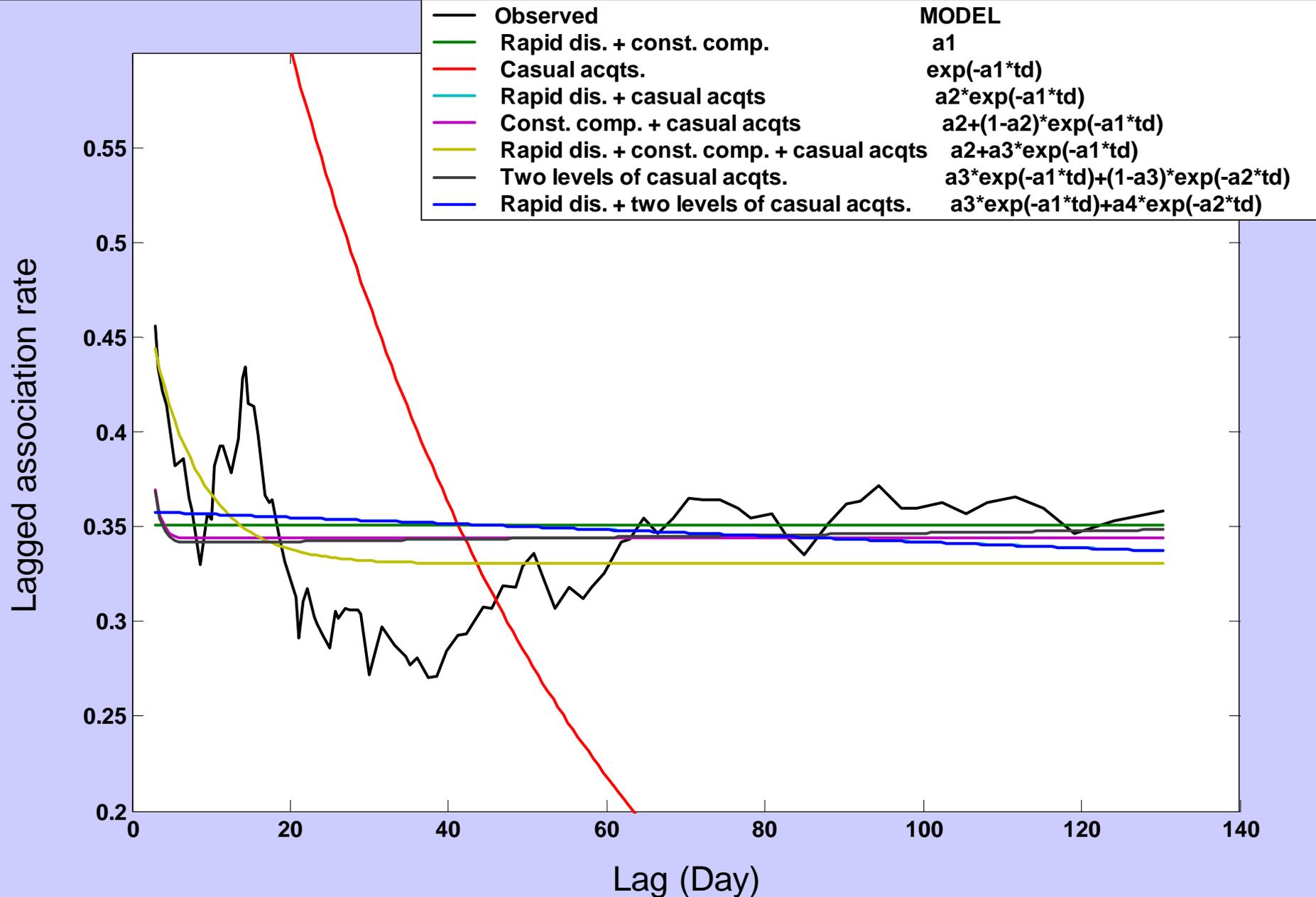
Genetic Relatedness



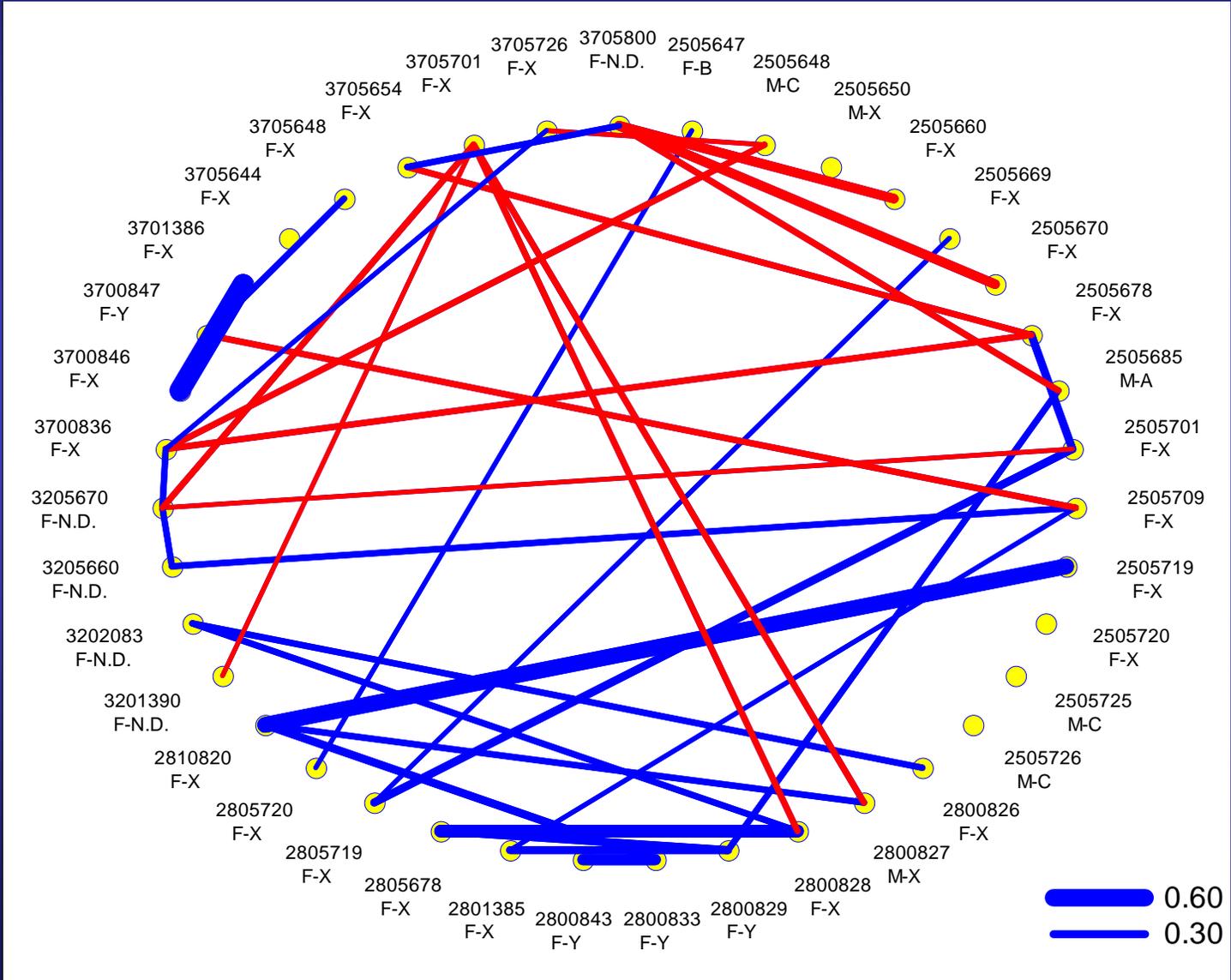
Comparison of Genetics and Social Structure

	2002	2002 Females only	2003	2005
<i>n</i>	12 F = 7 M = 5	7 F = 7 M = 0	11 F = 10 M = 1	9 F = 9 M = 0
Matrices Correlation	0.0899	0.1380	0.2482	0.6245
Mantel Z	-0.0462	-0.0383	0.2799	0.3938
<i>t</i>	0.7670	0.5894	1.8190	3.7014
<i>p</i> (<i>t</i>)	0.7783	0.7222	0.9656*	0.9998*
Permutations from <i>SocProg</i> and <i>MatrixTester</i>	0.7781	0.7181	0.9460	0.9976*
	0.7737	0.6980	0.9475	0.9979*

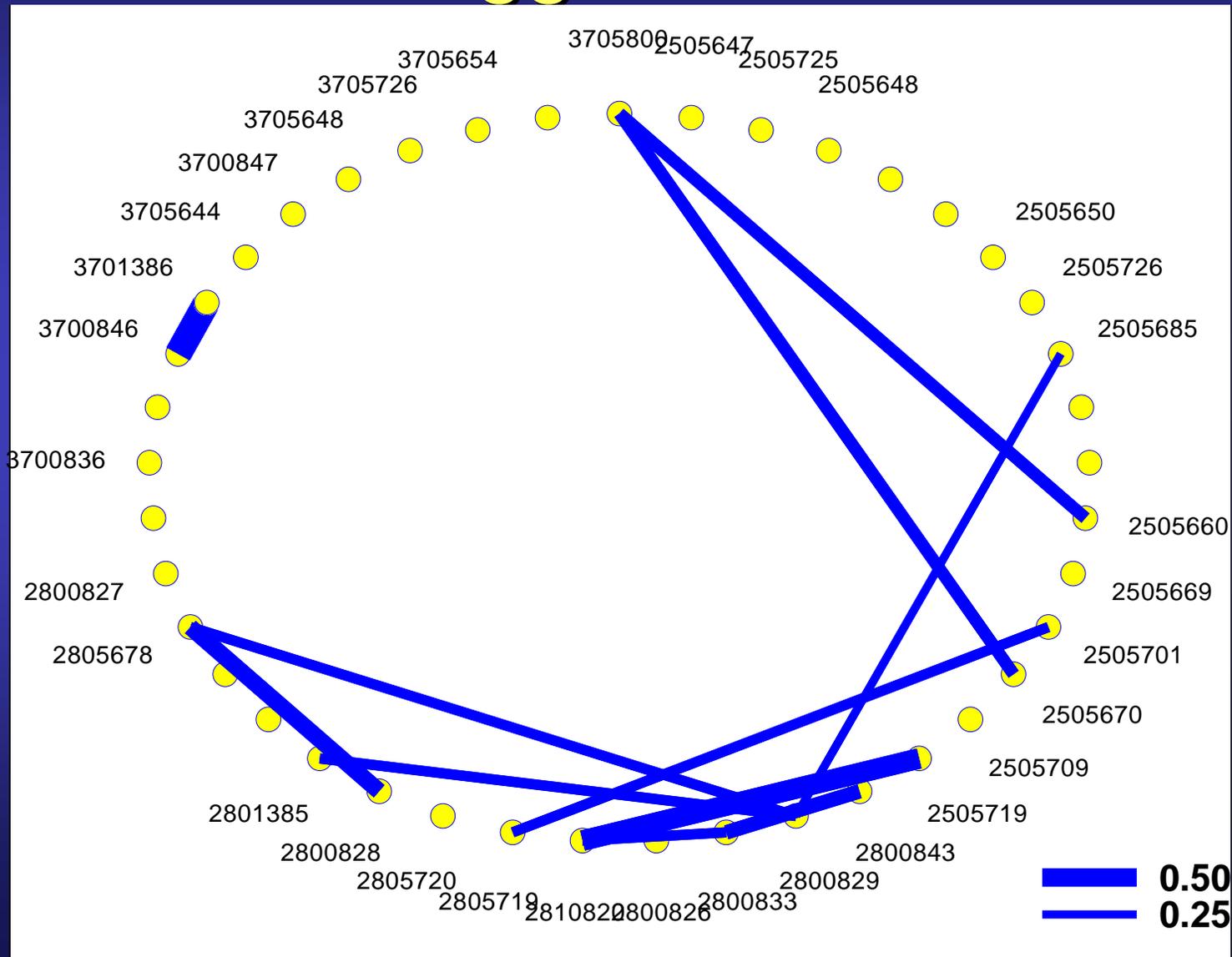
Temporal Variation of Association



Genetic Relatedness Among All Tagged Whales

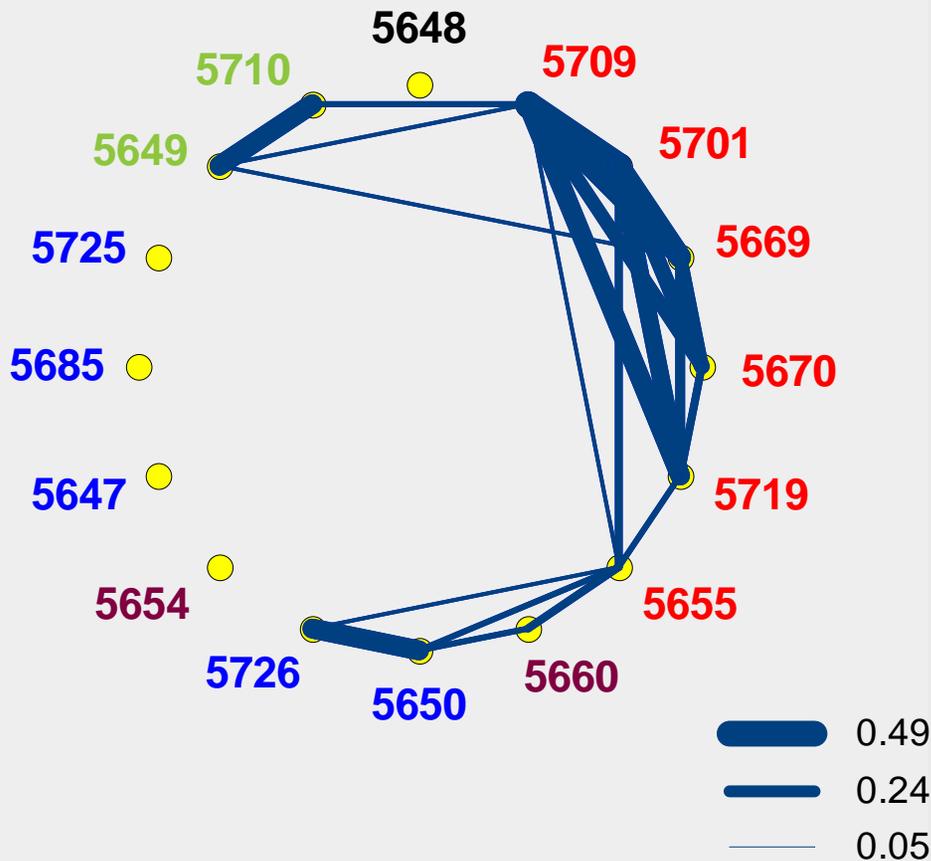


Genetic Relatedness Among All Tagged Whales



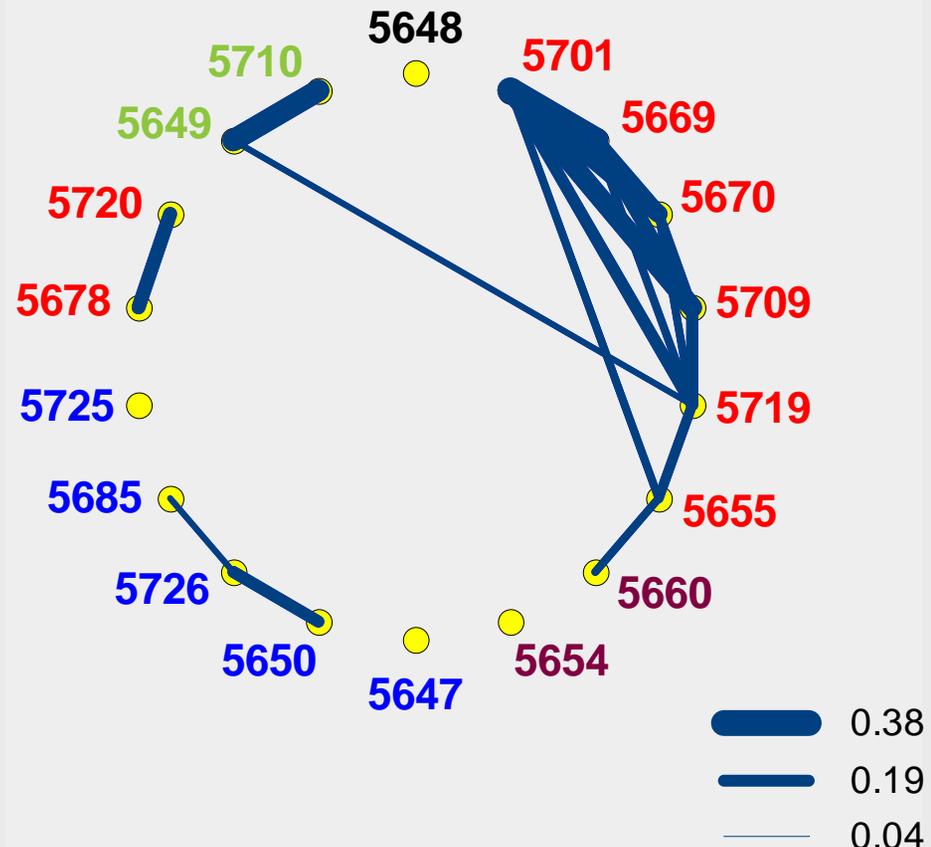
Association of S-Tagged Whales at Two Time Intervals

Deployment + days 46 – 84



AI

Deployment – day 255



AI

Summary

- S-tag data usable for social structure analysis
- Good temporal and spatial coverage but limited to tagged individuals
- S-tag data may not reflect short-term social structures (“clusters” and “aggregations”) but identify long-term “social units”
- Long term (months) associations between females
- No significant long term association between males
- Variability in genetic relatedness between members of social units
- Social structure of tagged whales coincides with observations in other areas (Galapagos)

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