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Forecasting the bird migration for the Finnish Air Force

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Why?

- Bird is a threat
- Threat is to be managed by threat assessment
- Threat assessment is an estimation process
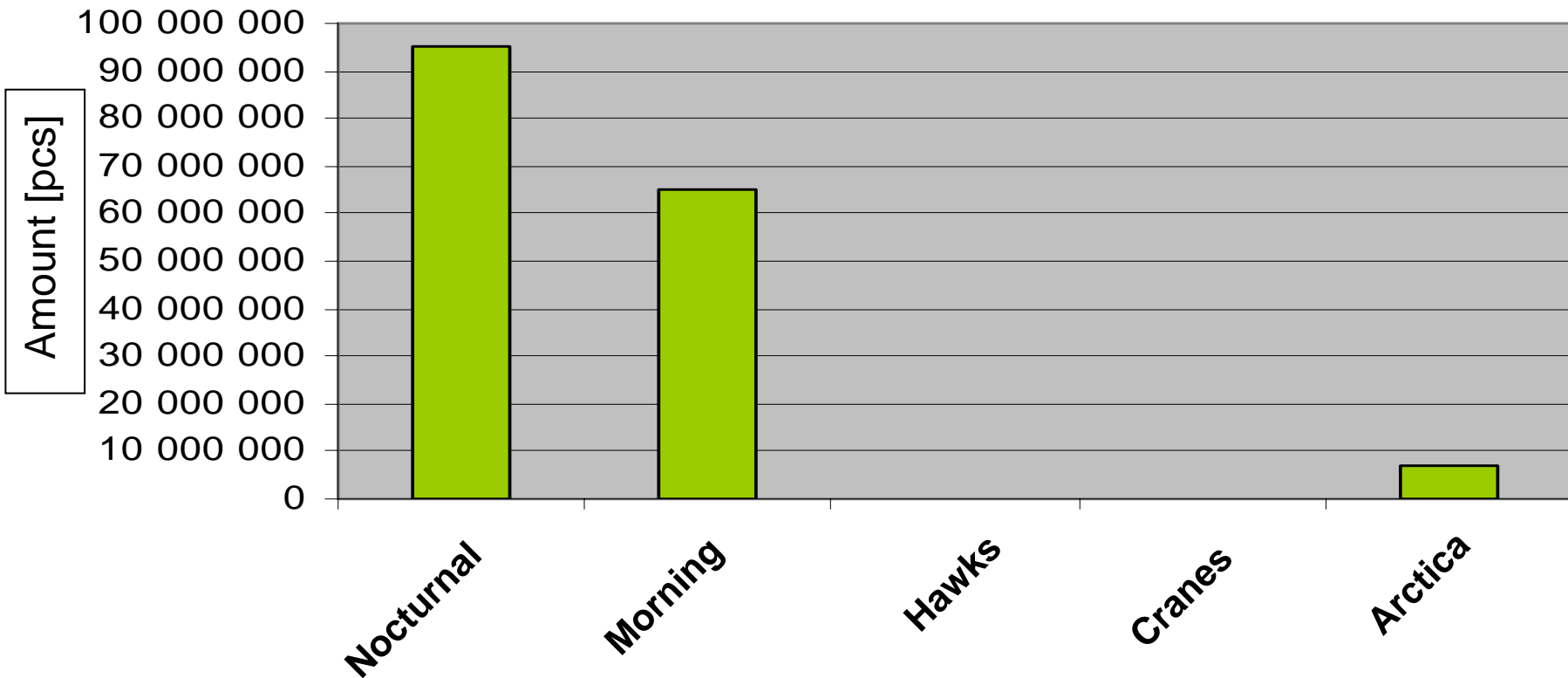- Part of the estimation is the predicition

What is "threat" all about?

"Know your enemy."

- Threat is non co-operative
- Threat is numerous
- Threat is indifferent
- Threat is statistical
- Threat behavior pattern is somehow predictable

"Numerous…"

Number of Migratory Birds (autumn, southern Finland)

Information source: Meteorological institute, Finland

Forecastig "migration"

- Forecasting what?
  - Time
  - Route and/or location
  - Number
  - ID
  - Intention
- Action
  - Be far away in location and/or time
  - Increase situation awareness
- Reduce risk

Migration Model

For detailed information: Finnish Meteorological Institute, Jarmo Koistinen

$$E = (P+N)*S$$

E= estimated migration [birds/day]
P= non migrated "scheduled" population
N= "scheduled" migration
S= weather factor

$$S = U*D*V*H*R*L*K$$

U= wind speed factor
D= wind heading factor
V= visibility factor
H= cloud factor
R= rain factor
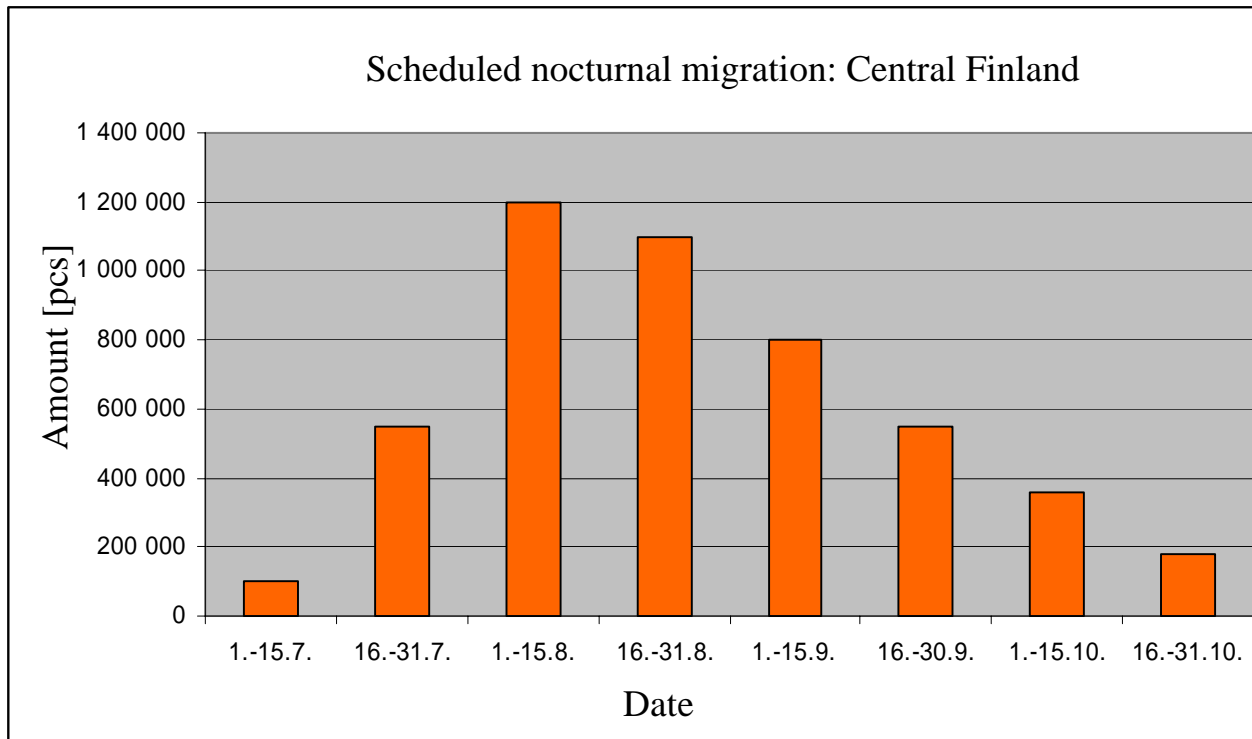L= snow and ice factor
K= convection factor

Modelling terms

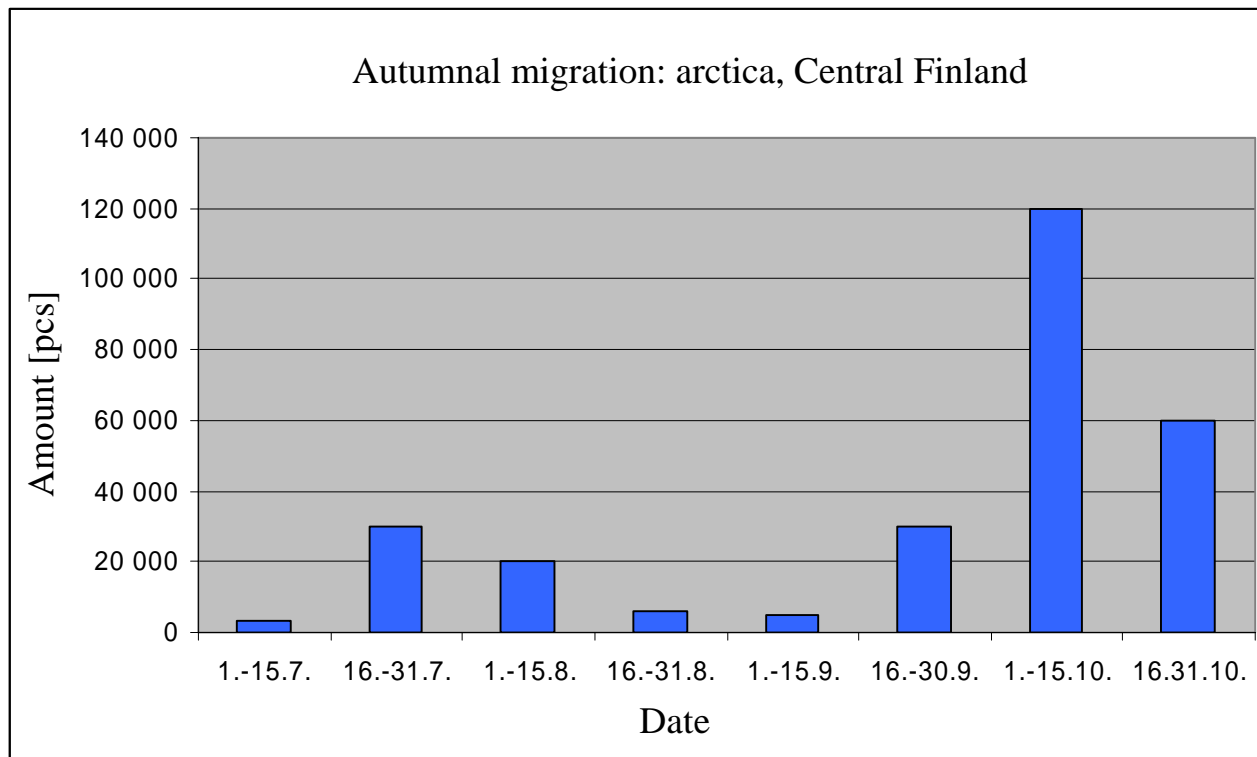For detailed information: Finnish Meteorological Institute, Jarmo Koistinen

$$E= (P+N)*S$$

Scheduled nocturnal migration: Central Finland

Information source: Meteorological institute, Finland

Modelling terms

$$E = (P+N)*S$$

Autumnal migration: arctica, Central Finland

Information source: Meteorological institute, Finland

Modelling ID

- Categories:
  - Nocturnal
  - Morning migrators
  - Convection mirgators
  - Arctic migrators

- Size:
  - Big
  - Medium
  - Small

- Convection migrators:
  - Predators
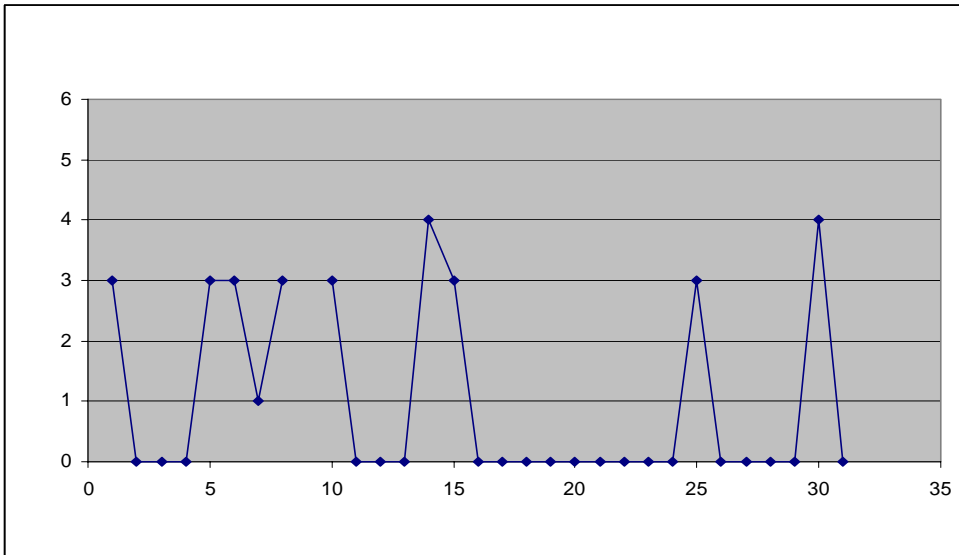 - Cranes

Outcome

Textual prediction provided by the Meteorological Institute as service for the military.

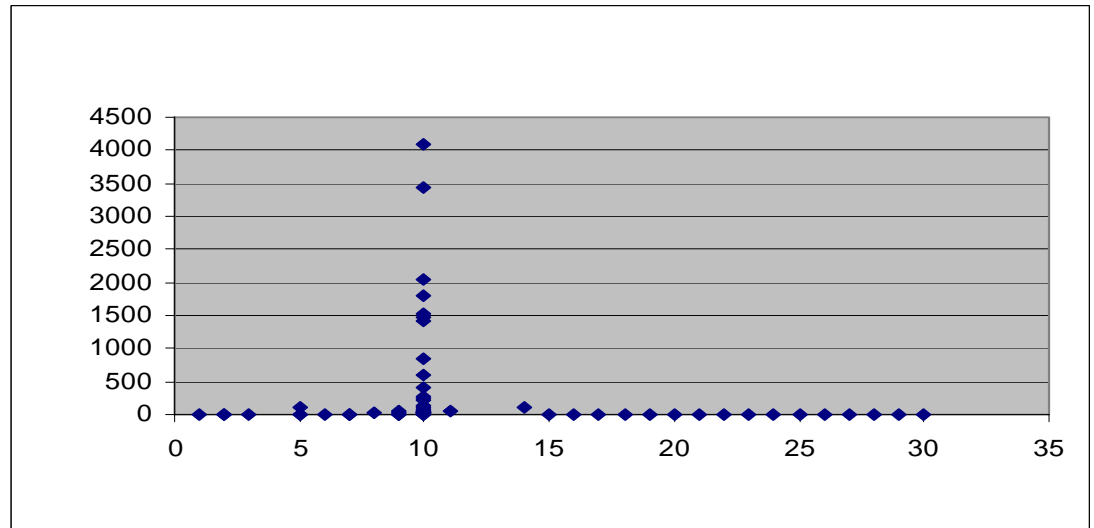Bird density is predicted per day per three main areas.

Prediction is part of the morning debriefing in the Air Force Commands.

Uncertainty

Crane migration prediction Sept 2006
Y-axis: migration index [0,5]
X-axis: day of Sept

Crane migration observations, Sept 2006
Y-axis: observed local cumulations
X-axis: day of Sept
Dot: observation point report

Information source: Bird Life Finland

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What went wrong on 28.9.2006?

HW-335

Anas penelope

PUOLUSTUSVOIMAT | FÖRSVARSMAKTEN | THE FINNISH DEFENCE FORCES
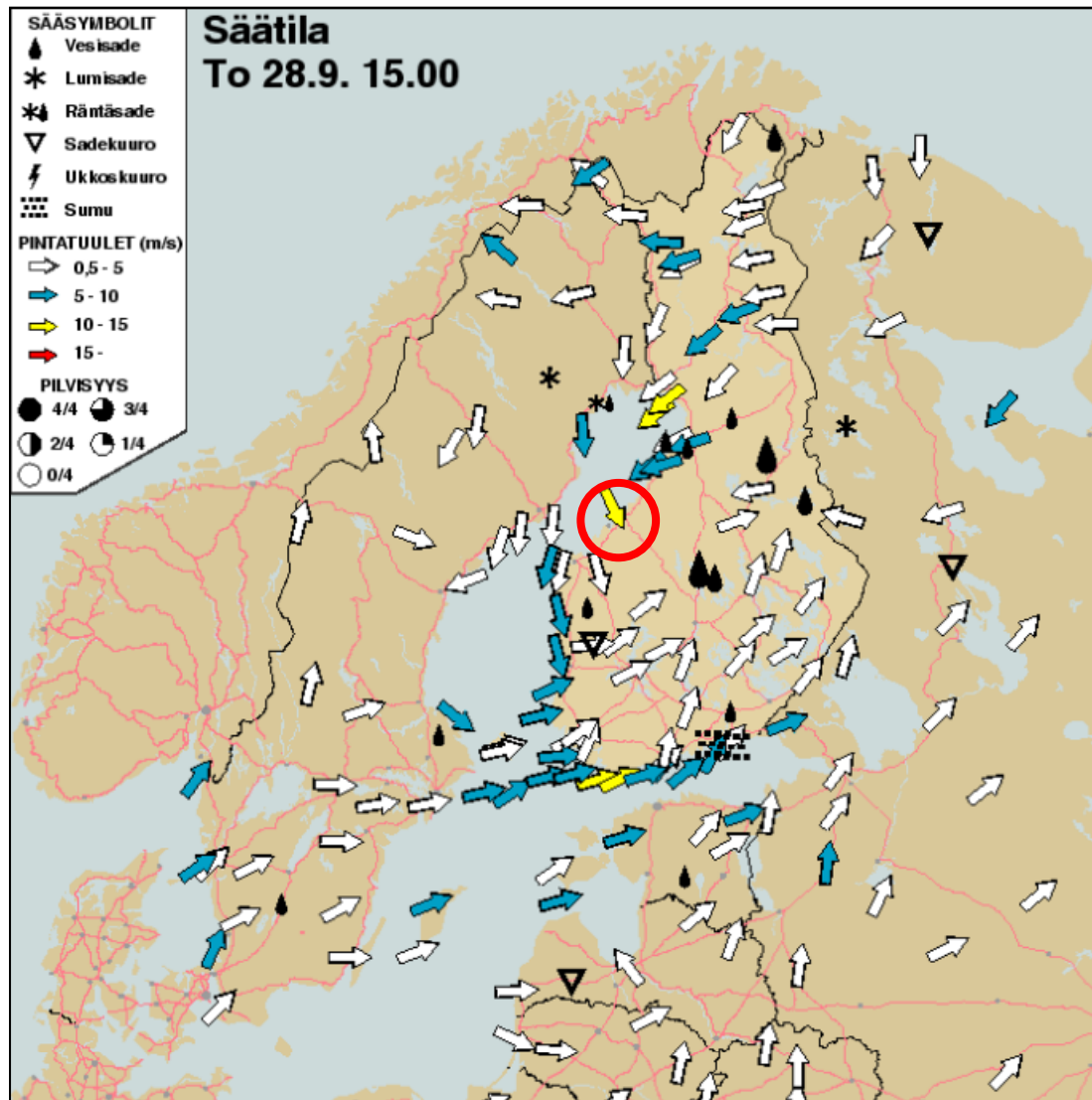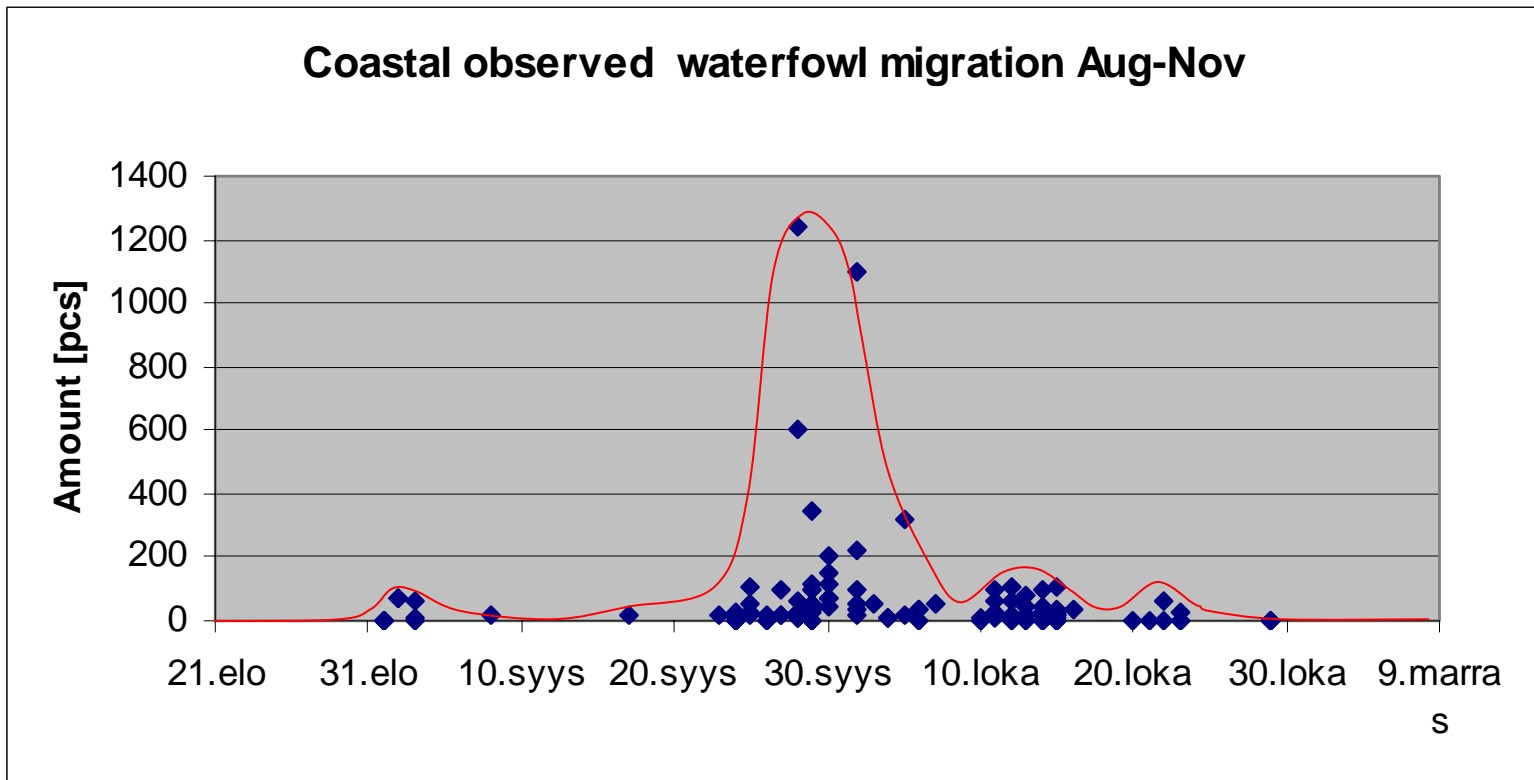
Weather?

- Optimal for coastal autumnal migration

- Exercise just there that time…

Information source: Finnish Air Force

Ground truth?

Coastal observed waterfowl migration Aug-Nov

Information source: Bird Life Finland

Anas penelope Ground Truth

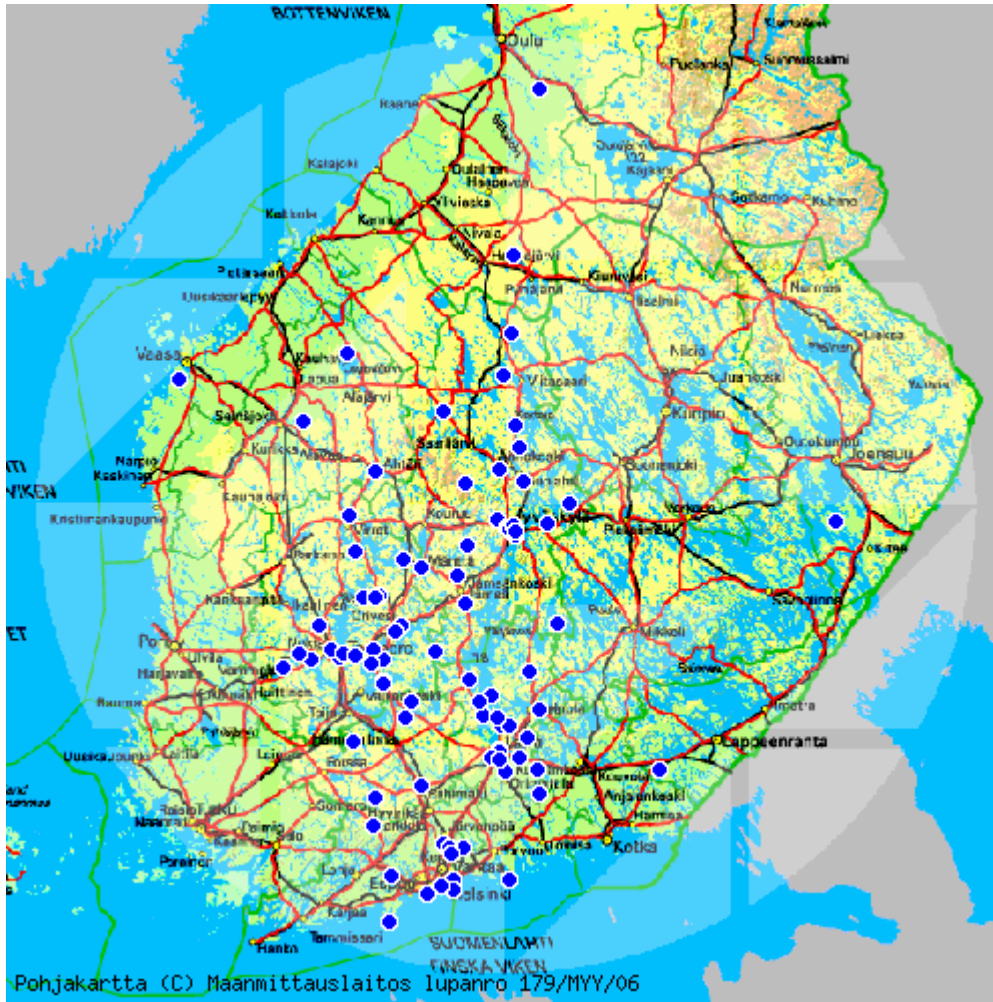Information source: Bird Life Finland

Conclusion

- Wrong general planning
- Wrong general timing
- Wrong actual timing
- Wrong actual placing
- No reaction to actual weather
- Ground truth not known
- Prediction resolution inadequacy

- No local estimate available
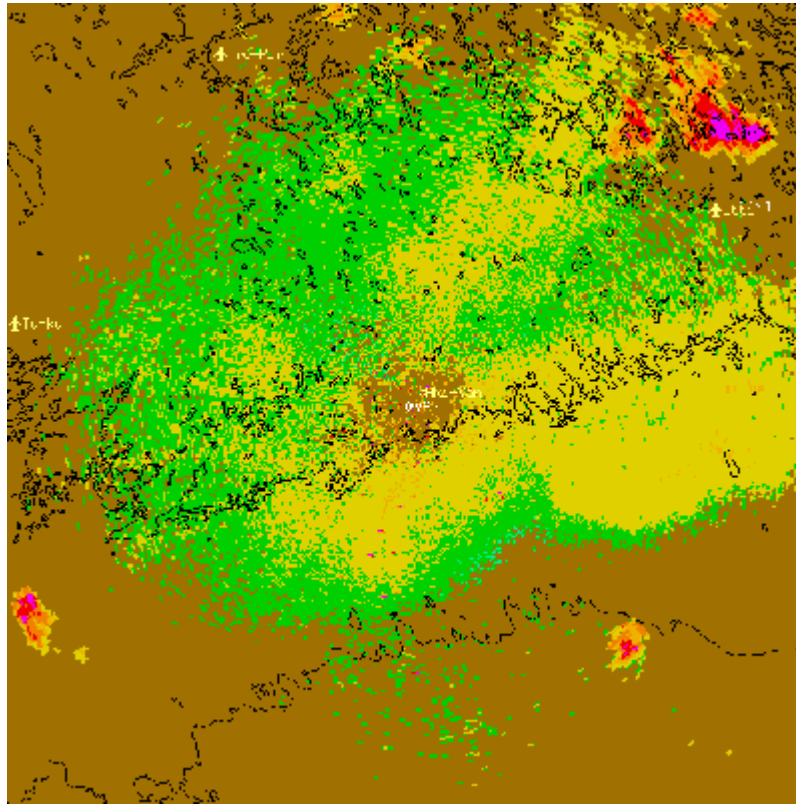- Risk not assessed

Information sources

Birders' information

Information source: Bird Life Finland

Crane migration 10.9.2006

Start area known in advance
Start timing reported real time
Course predicted in advance
Course estimated real time
Timing uncertainty 1 h
Location uncertainty 50 km

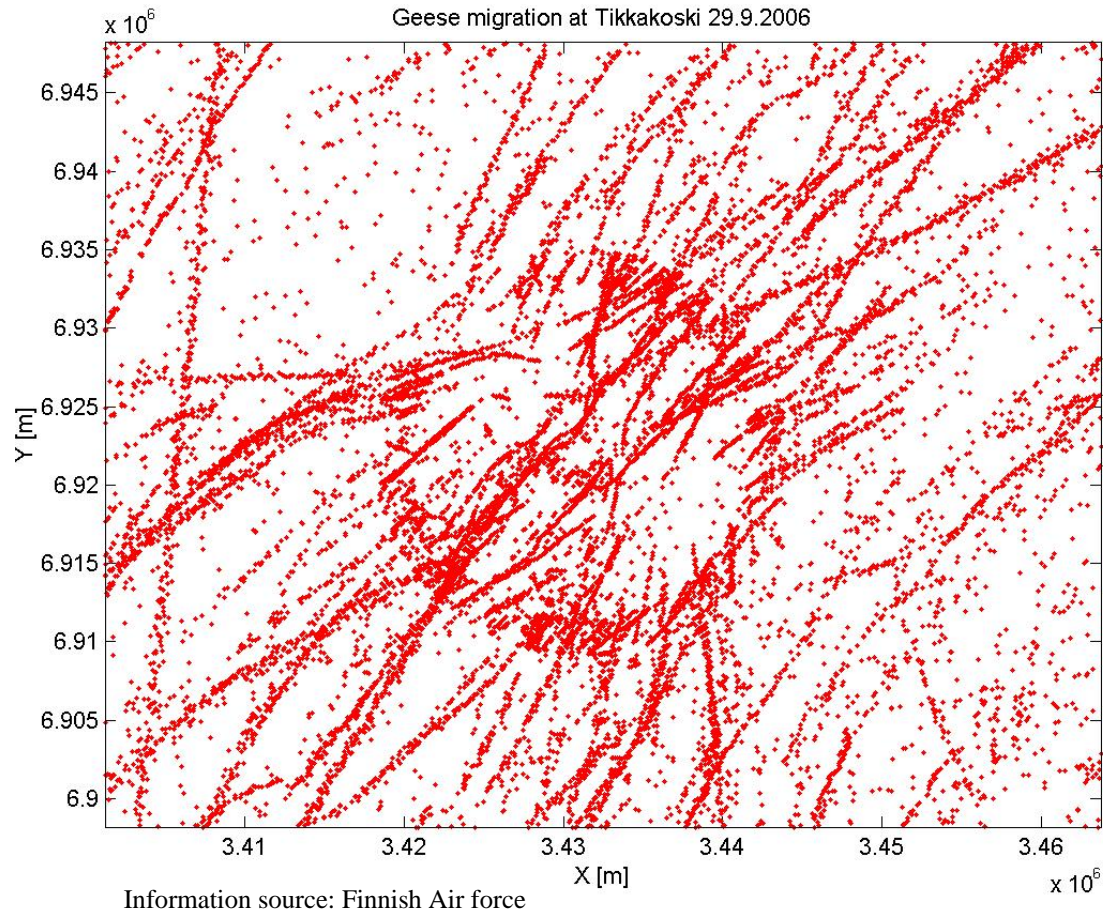# Weather radar information

Information source: Meteorological institute, Finland

Surveillance radar information

Geese migration at Tikkakoski 29.9.2006

Information source: Finnish Air force

2DO

- Several improvements can be found
- Go from prediction to estimation
- Implement ground truth
- Occupy birders
- Utilize weather radar
- Utilize surveillance radar
- Improve prediction
- Computerize it – make it part of the Picture

What can be achieved?

- Zero strike situation: NO
- Single bird awareness: NO
- Single flock awareness: NO

- Better spatial resolution: YES
- Better temporal resolution: YES
- Statistical reduction of risk: YES