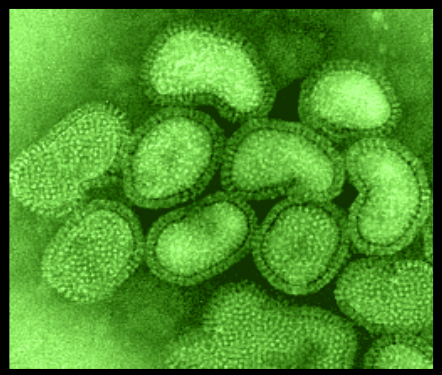
Ecology of avian influenza viruses in wild birds in the Camargue (Rhône Delta, France)



ANR Santé-Environnement et Santé-Travail MigrAvFlu

. Centre de Recherche de la Tour du Valat

. Unité de Génétique Moléculaire des Virus Respiratoires- Institut Pasteur

. UMR 2724 (IRD/CNRS). Génétique et Evolution des Maladies Infectieuses

. CNERA-ONCFS

. CRBPO, MNHN

. CEFE-CNRS (T. Boulinier)

. INRA- INA-PG

TOUR DU VALAT

INSTITUT PASTEUR

IRD
Institut de recherche pour le développement

CNRS
CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE

Office National de la Chasse et de la Faune Sauvage

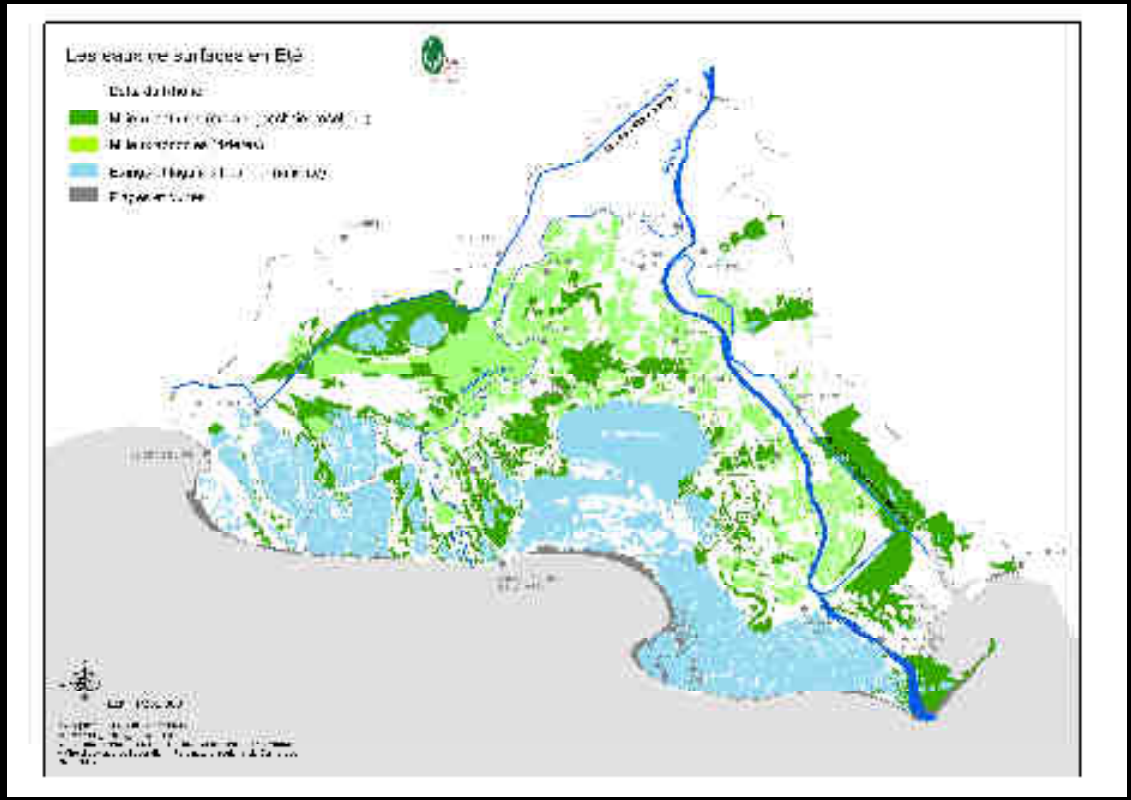
- The Camargue...

- Rhone delta (south of France).

- 145 500 ha.

- Wide variety of aquatic ecosystems and land use

Wildlife reserves



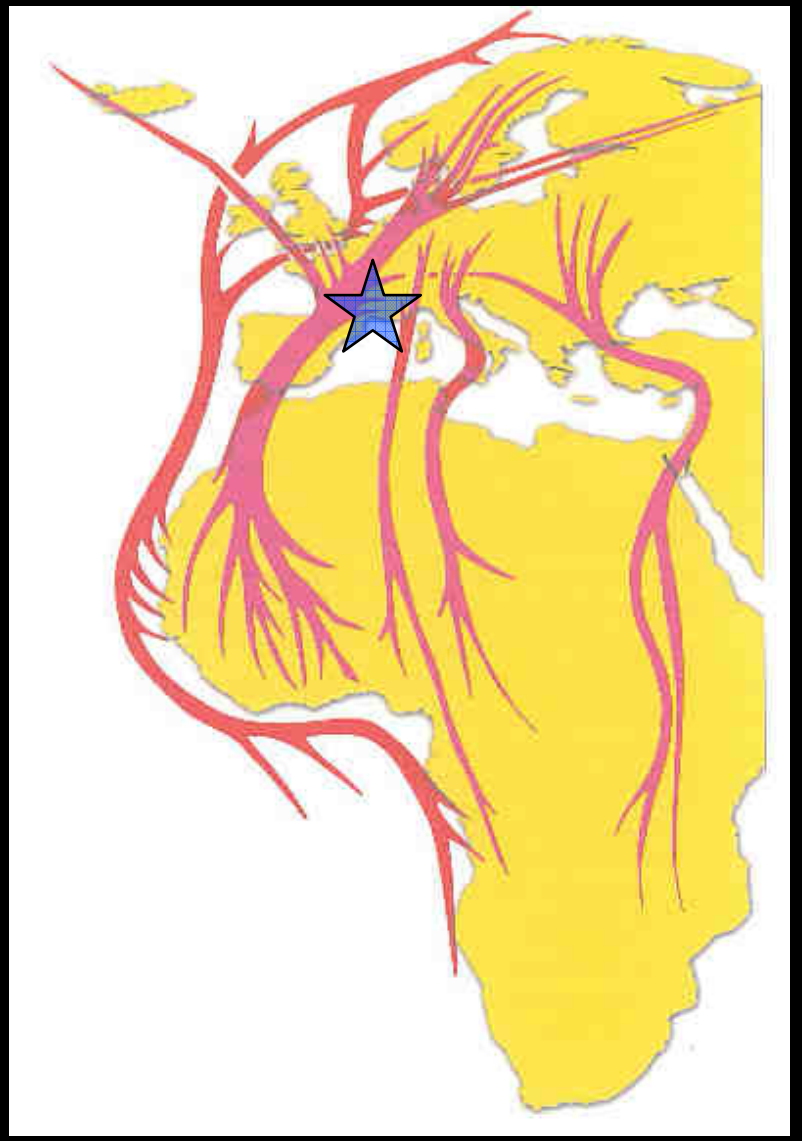
Hunting marshes

Rice farming

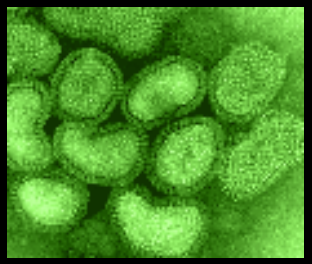
Salt marshes

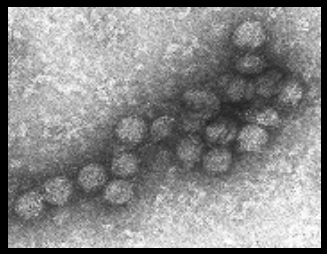
- The Camargue...

... at the crossroads of
numerous migratory routes

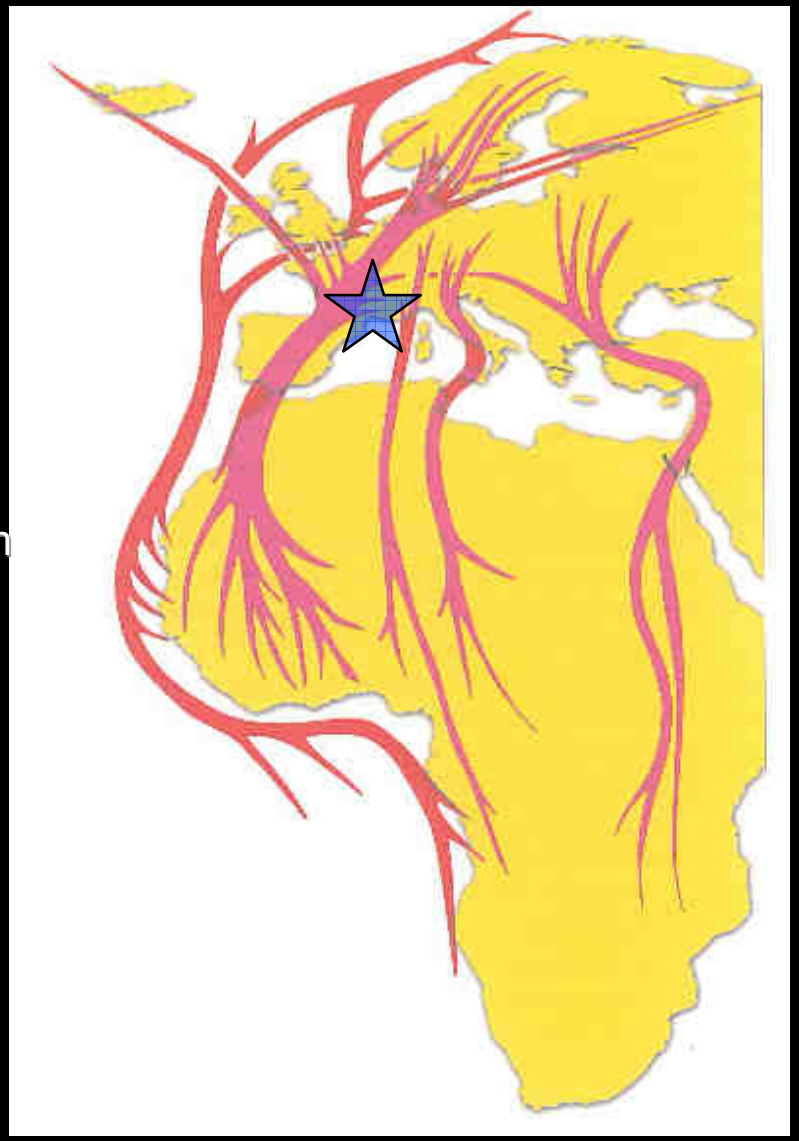


- The Camargue...

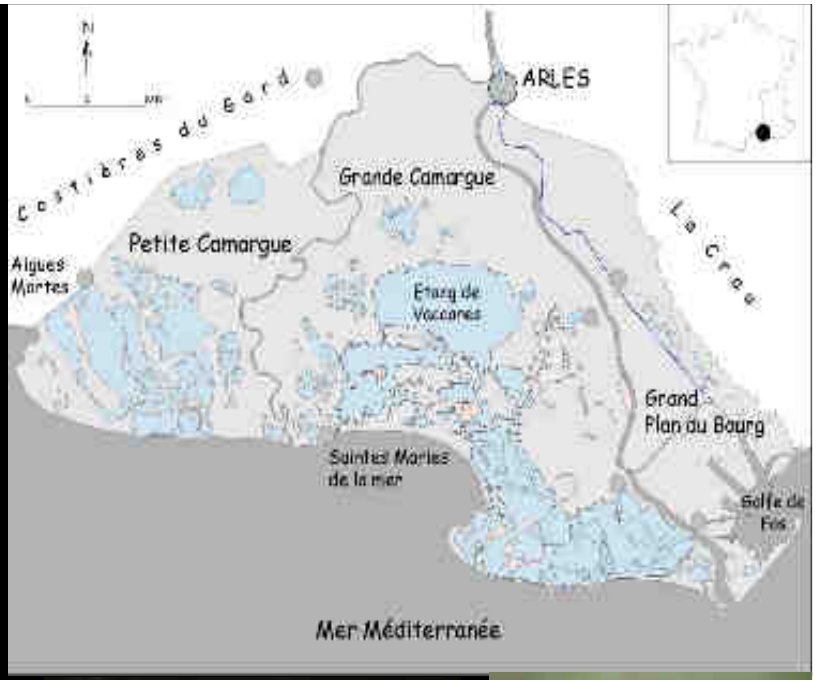




... hot spot for the risks of introduction and transmission of pathogens !



- **Global pattern of AIV circulation**
  - *AIV prevalence*
  - *Seasonality of AIV infection*
  - *Hosts involved*
- **Genetic characteristics of AIV**
  - *Molecular subtyping*
  - *Phylogeny*
  - *Interspecific exchanges*
- **Modelisation**



- Bird sampling:

Funnel live-traps

Hunters

Mist nets

Cloacal swabs

Fresh dropping samples

- **Molecular analysis and virology**
  - **AIV detection**
  - **HP, LP**
  - **Isolation**
  - **Subtypes characterization**

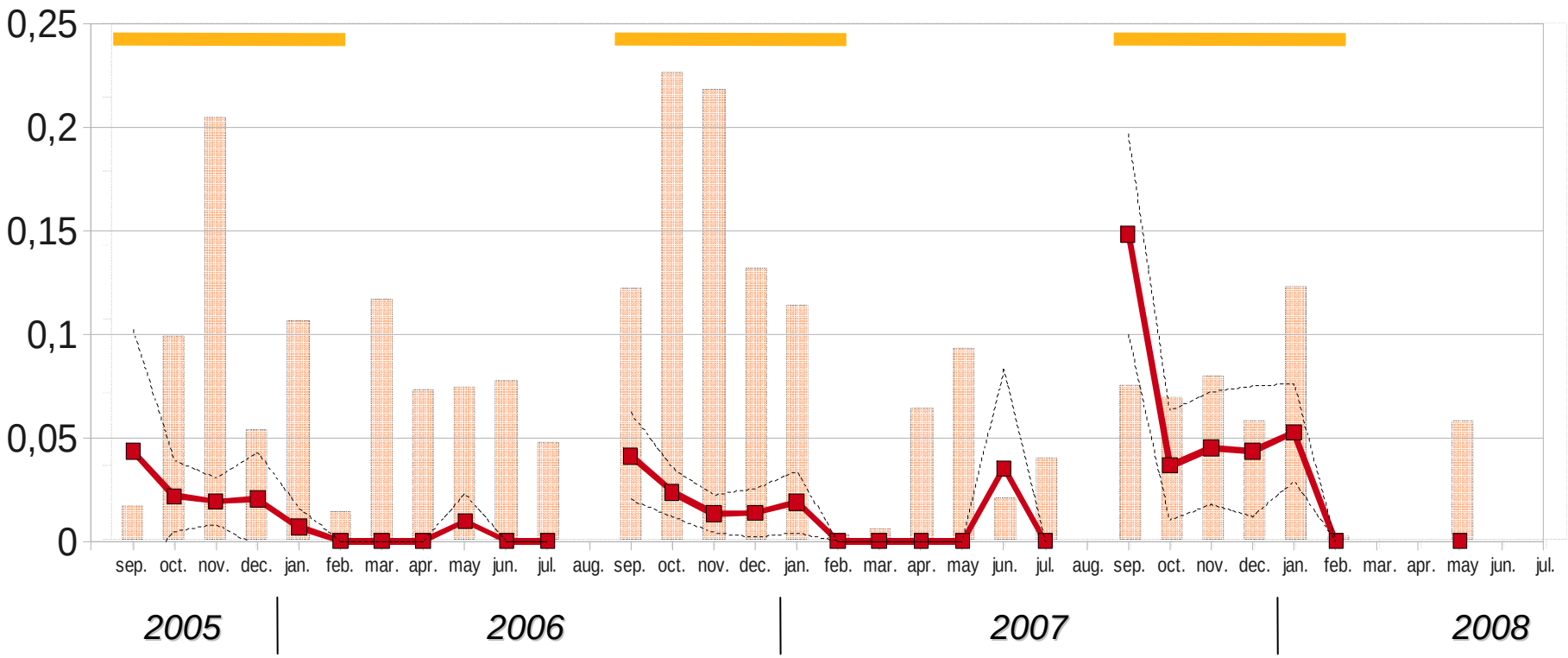
Unité de Génétique Moléculaire
des Virus Respiratoires

INSTITUT PASTEUR

- Bird sampling (from fall 2005 to spring 2008)
  - 6792 samples from 121 bird species.
  - 150 AIV detected in 9 bird species.

Global prevalence of infection in the Camargue bird community: 2.2%.

- AIV prevalence (from fall 2005 to spring 2008)



- Consistent pattern between years and seasons: higher infection rates during the wintering periods (Sep. to Feb.).

(GLM; OR = 14.7; CI = [5.4 – 39.6]; P < 0.001)

AIV prevalence.

Confidence interval (95%).

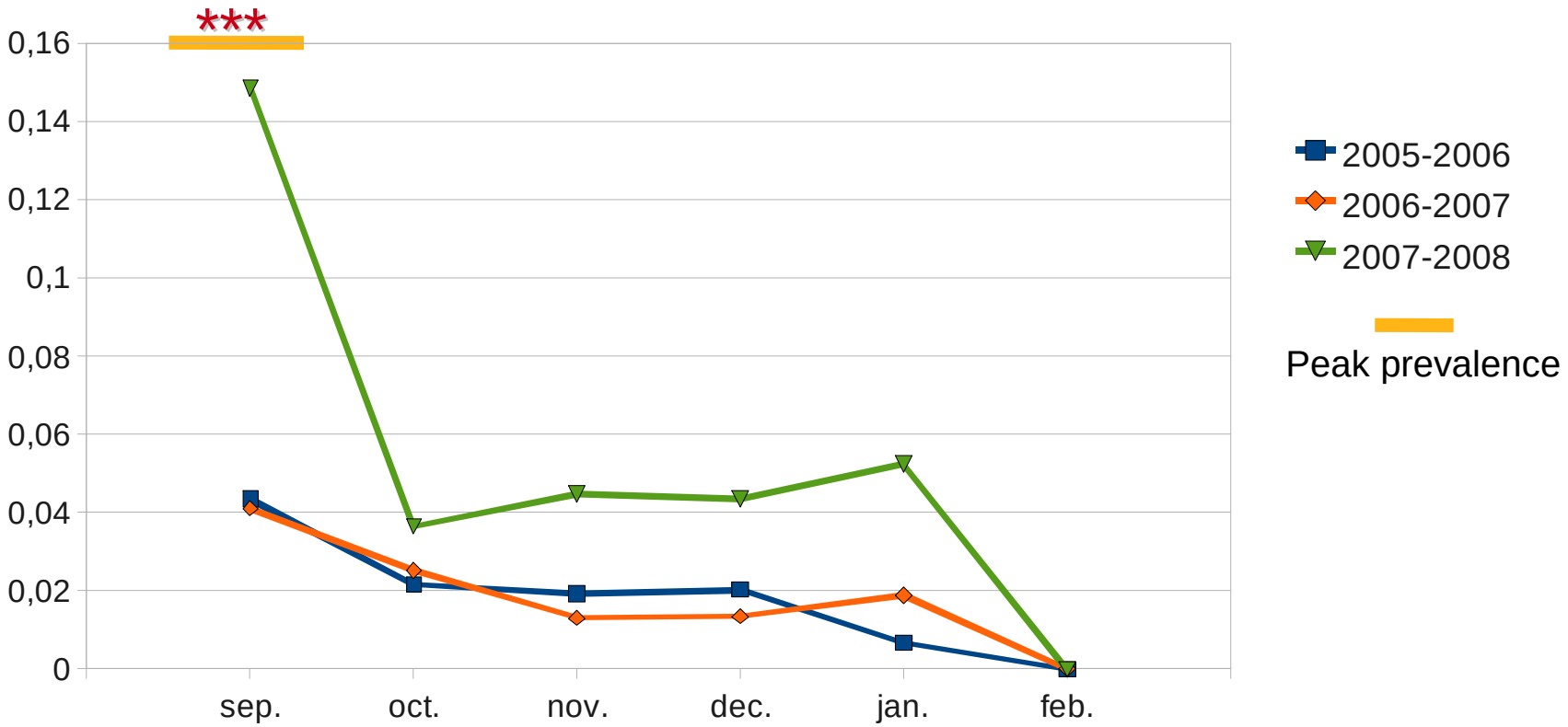
"wintering period".

Seasonality of AIV infection

- AIV prevalence during wintering periods

Anseriformes (3.9%, N=3659, mainly ducks).

(GLM; OR = 31.2; CI = [11.5 – 84.2]; P < 0.001)



- Higher infection rates in 2007-2008.

GLM; OR = 3.1; CI = [1.9 – 4.9]; P < 0.001

- Peak prevalence in September.

(GLM; OR = 3.1; CI = [1.9 – 5.0]; P < 0.001)

- Infected duck species

Species	*Prevalence*	*Sample size*
Northern Pintail (*Anas acuta*) *Canard pilet*	1%	100
Northern Shoveler (*Anas clypeata*) *Canard souchet*	3.2%	282
Common Teal (*Anas crecca*) *Sarcelle d'hiver*	5.3%	1798
Mallard (*Anas platyrhynchos*) *Canard colvert*	4.4%	767
Garganey (*Anas querquedula*) *Sarcelle d'été*	10.3%	29
Gadwall (*Anas strepera*) *Canard chipeau*	1.3%	237
Common Pochard (*Aythya ferina*) *Fuligule milouin*	0.3%	201

(GLM; OR = 11.4; CI = [1.1 – 114.4]; P < 0.5)

- AIV during spring and summer

Charadriiformes (N=945, mainly gulls):

- Mediterranean gull (2.8%, N=71)
- Yellow legged gull (0.5%, N=369)

→ *Breeding colonies*

Absence of positive detection in:

- Ciconiiformes: herons, egrets, etc. (N=177)
- Phoenicopteriformes: greater flamingo (N=312)

→ *Breeding colonies*

- Passeriformes: 60 species (N=1599)

→ *During migration (spring and fall)*

- Clear seasonal pattern of infection in ducks (*Anas sp.*) with highest prevalence at the beginning of the wintering period.

- Passerine birds are not affected by AIV infection in the Camargue.

- Absence of circulation of HP

- High level of circulation of H1 (12%, H1N1), H5 (21% ; majority H5N2 and H5N3), and H9 (8% ; half H9N2) AIV compared with other studies performed in Europe.

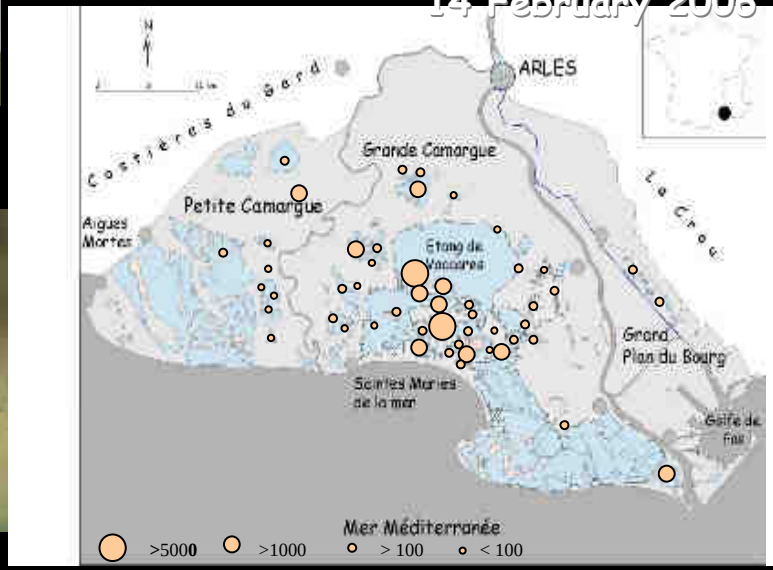
- Circulation of H9 AIV in the Camargue and possible inter-continental genetic exchange with northern America.

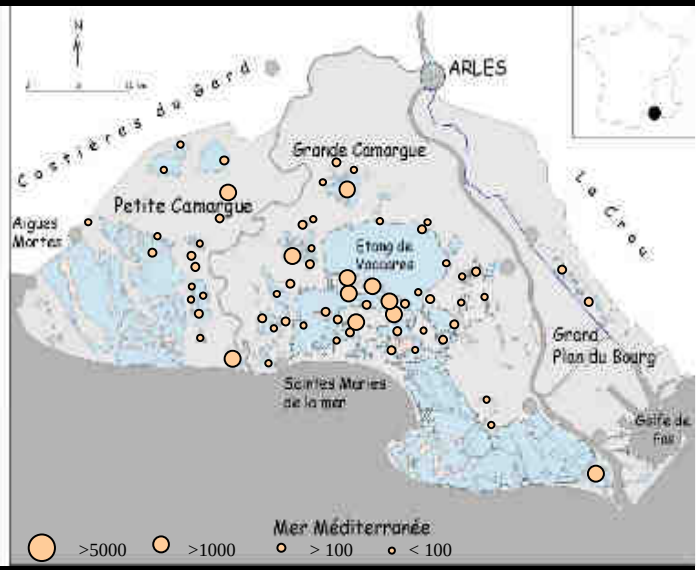
Bird number and spatial distribution

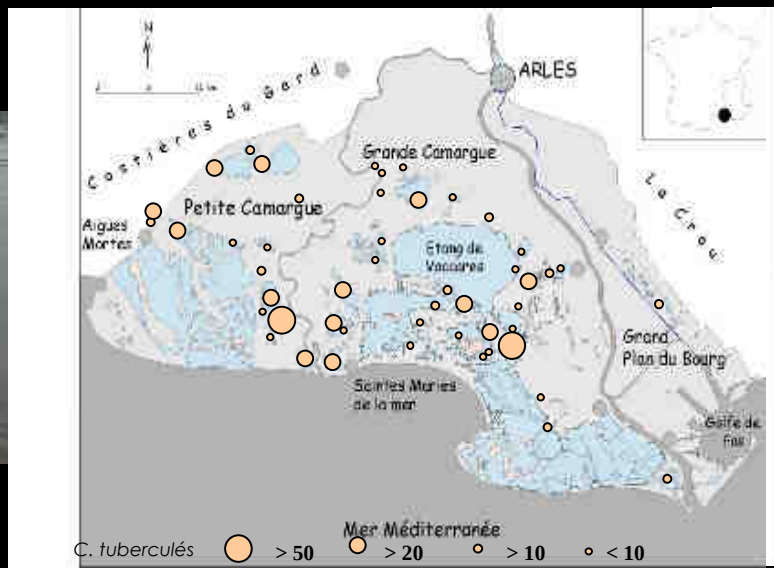
Winter 2005-2006

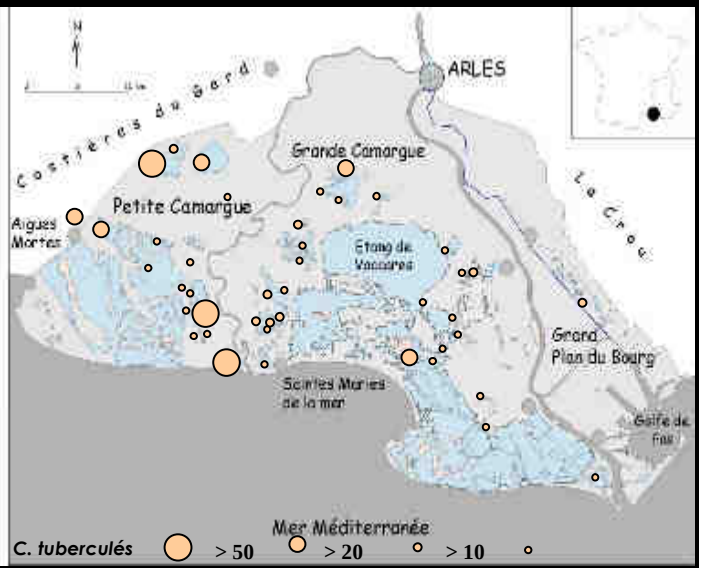
10 January 2006

14 February 2006

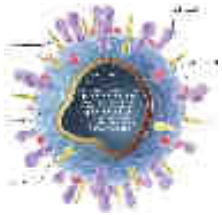








Winter 2005-2006



Molecular analysis

1345 wild waterbirds of 17 common species




Species known to **breed** in eastern or central **Siberia**, where **HP H5N1** was recorded during **summer 2005**.

No detection of HP H5N1

Waterbird monitoring

Census performed monthly:

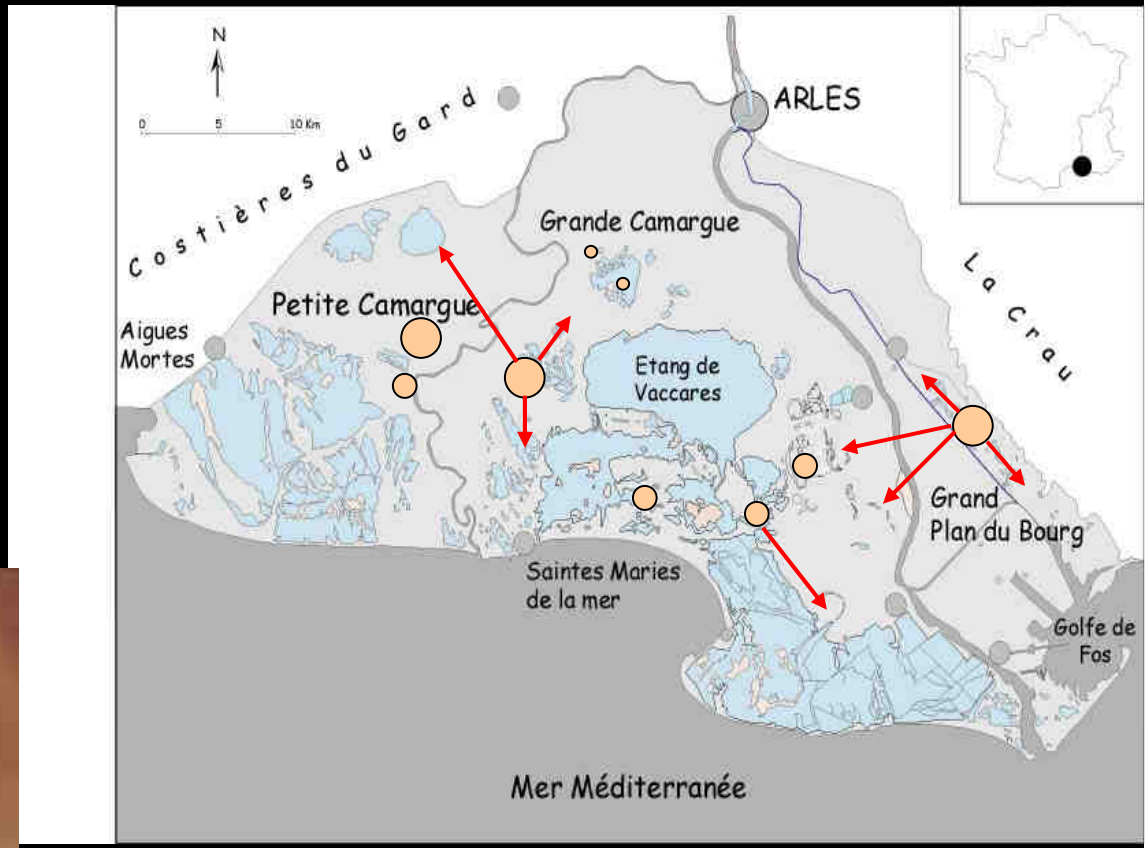
Comparison with data recorded since 1964

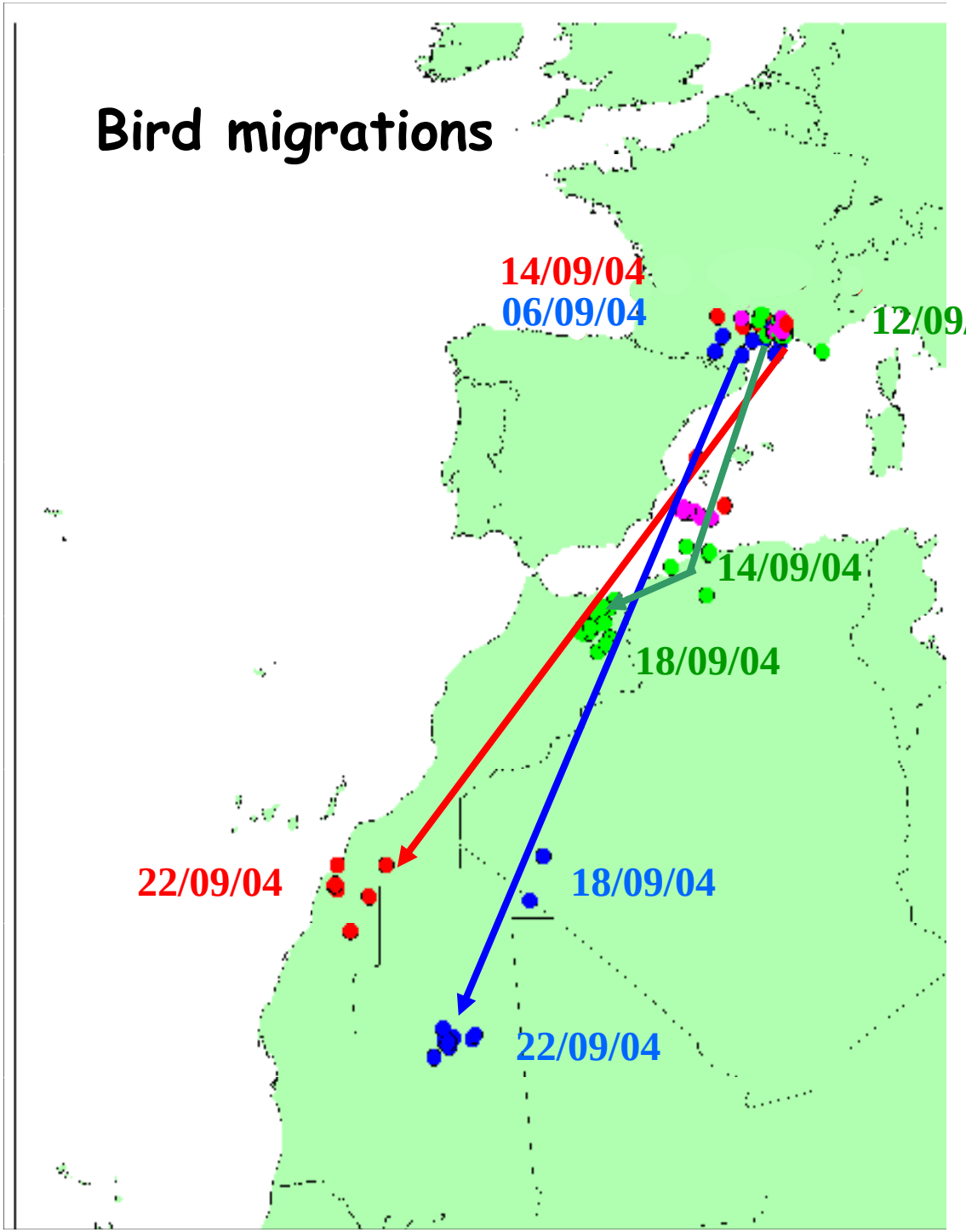
No abnormal population reduction

Mortality surveillance

No abnormal mortalities

Local movements during winter



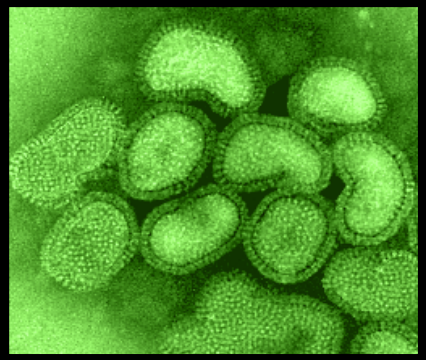


Juvenile Purple herons with satellite transmitters

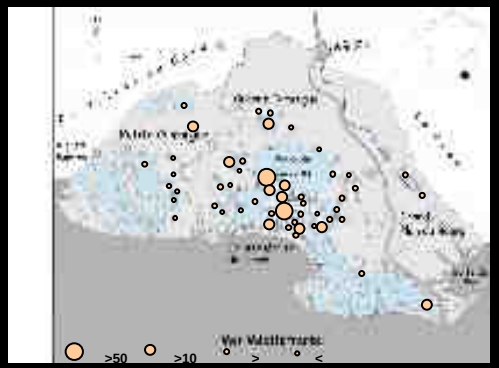
N=70 000 ringed teals

Modelisation

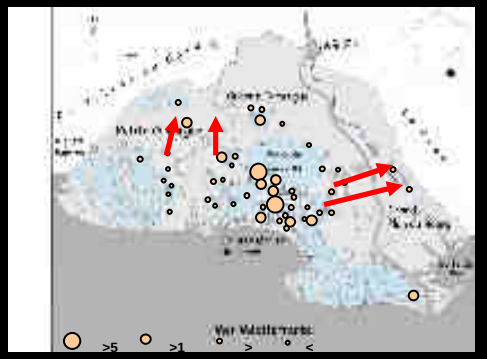
AIV



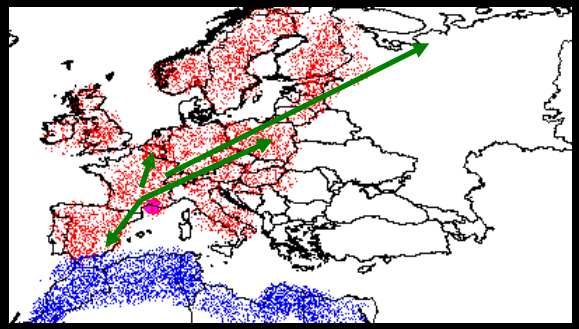
Bird number and spatial distribution



Local movements of birds



Bird movements between wetlands



Modelisation

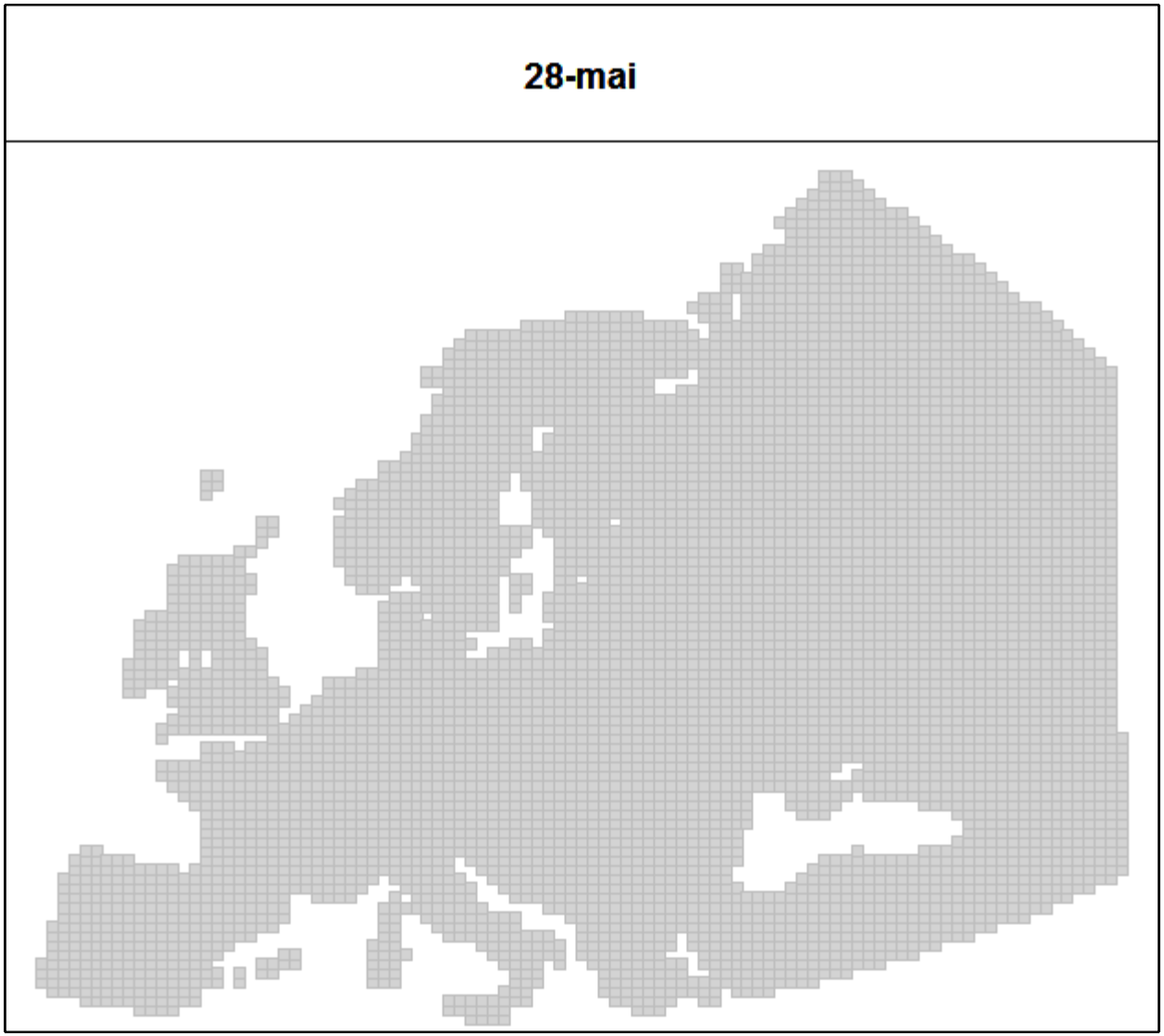
Habitats

N=70 000 ringed teals

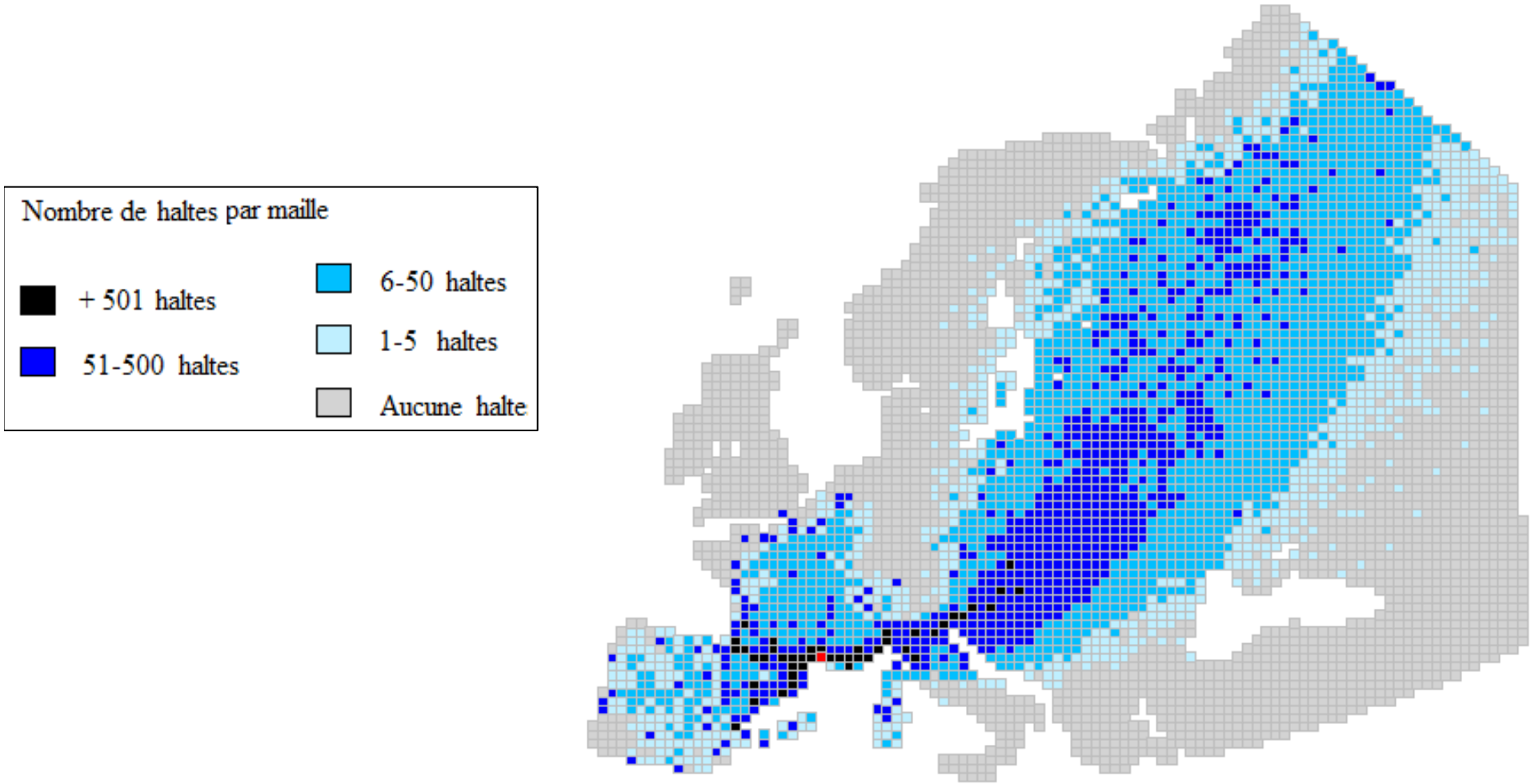
Results of simulation of migration

Nombre d'individus simulés par maille :

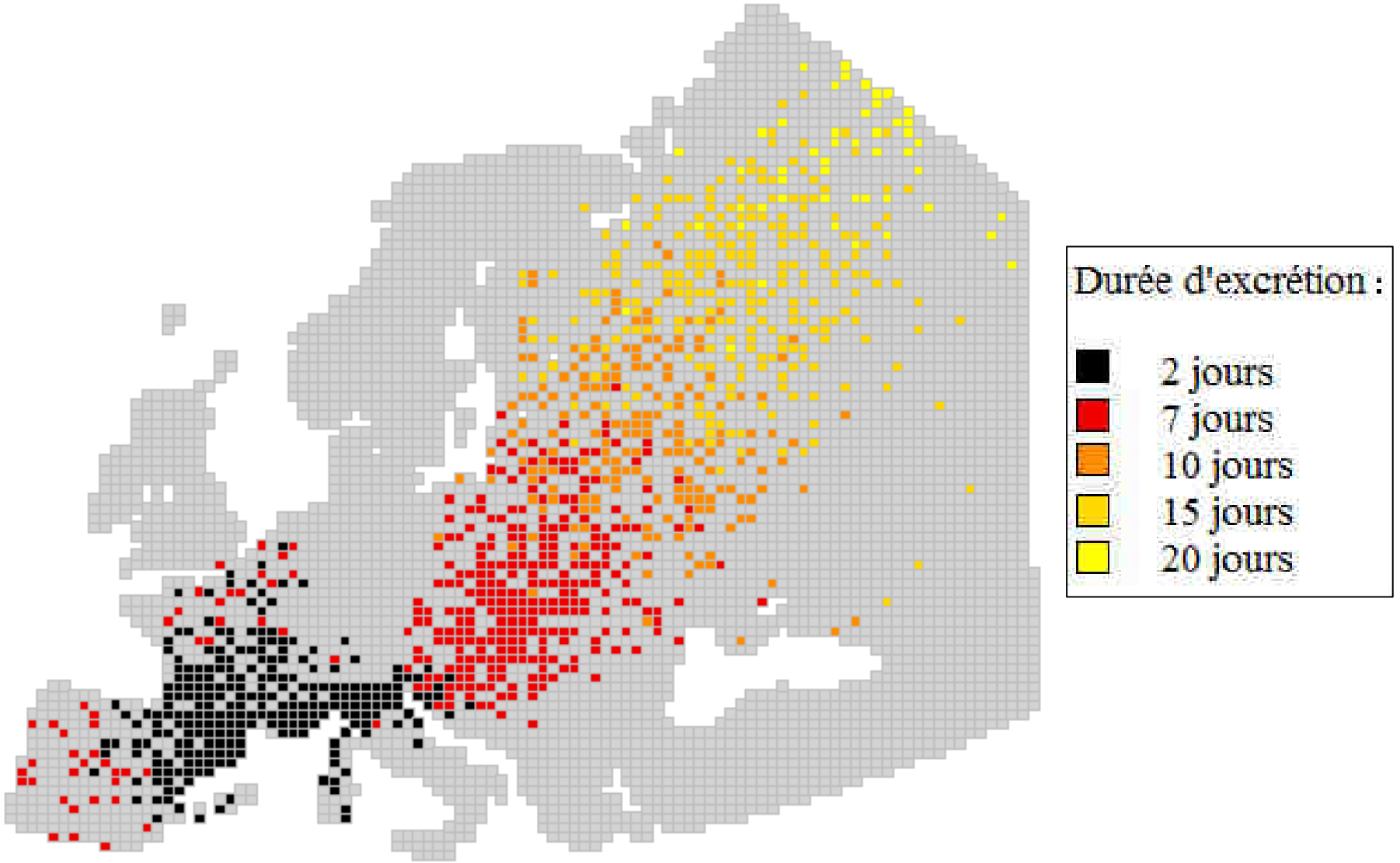
- + de 30 individus
- 15 - 29 individus
- 2 - 14 individus
- 1 individu
- Aucun individu



Map of stop-over probabilities



Virus dispersal according to time of excretion



Local dispersal of the AIV by wintering wild ducks

- Natural versus artificial ecosystems: different ecological constraints for AIV evolution ?

Ecosystem

Wild populations — *Domestic birds*

Ecological features

high	Intra- and inter-specific diversity	low
variable	Host density	stable
migration	Host dispersal	human trade
present	Predation risk	absent
required	Aquatic phase	Not required

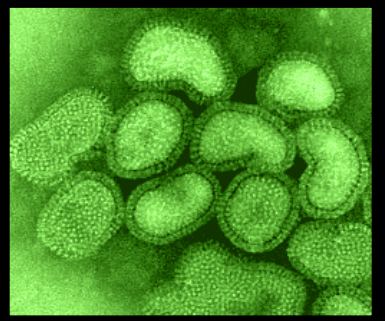
Virulence selection

LP AIV — *HP AIV*

ARDIGRIP

Axe Environnement et Transmission

Écologie évolutive et modélisation de la circulation des virus Influenza aviaires dans l'environnement



INSTITUT PASTEUR

CNRS CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE

IRD Institut de recherche pour le développement

TOUR DU VALAT

Ecole Nationale Vétérinaire de Lyon

Principaux Partenaires scientifiques

Sud

- École Inter-Etats des Sciences et Médecine Vétérinaires, Sénégal (A. Akokpo)
- Faculté des Sciences de Gabès, Tunisie (S. Selmi)
- Mahidol University, Thailande (P. Kittayapong)
- Université d'Annaba, Algérie (Y. Chabi)

Nord

- CEFE-CNRS (T. Boulinier)
- Centre de Recherche de la Tour du Valat (M. Gauthier-Clerc)
- CNERA Avifaune Migratrice, ONCFS (M. Guillemain)
- CRBPO, MNHN (O. Dehorter et D. Couvet)
- Ecole Nationale Vétérinaire de Lyon (M. Artois, D. Bicout)
- GEMI- UMR CNRS/IRD (F. Renaud, F. Thomas, J.-F. Guégan)
- Génétique Moléculaire des Virus Respiratoires, Institut Pasteur (S. Van der Werf)
- IRD, UR 178 (M. Souris)
- Université de Pau (M. Artzrouni)

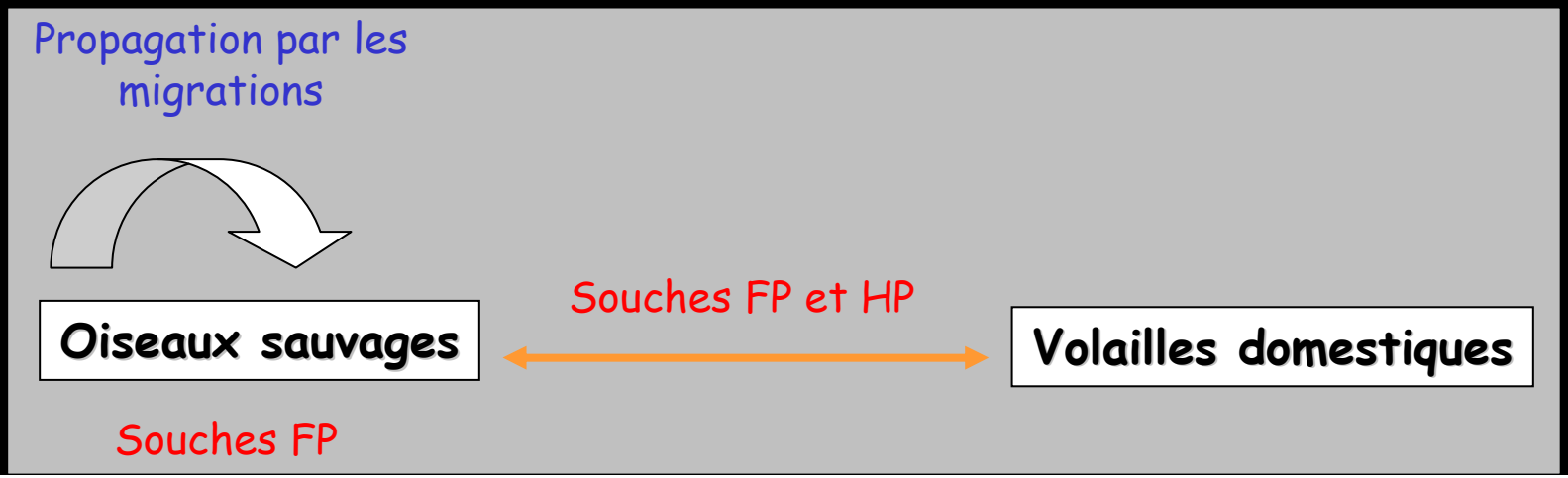
Principaux objectifs

Objectif 1. Écologie évolutive des virus Influenza aviaires dans l'avifaune sauvage

- Analyse de la dispersion et de la diversité des sous-types de virus Influenza aviaires en fonction des populations hôtes et de leurs origines géographiques

- Immunoécologie dans l'avifaune sauvage

- Transmission des virus Influenza aviaires aux élevages de volailles en plein air



Principaux objectifs

Objectif 2. Modélisation épidémiologique de la circulation des virus Influenza aviaires dans l'environnement

- Modélisation des migrations des oiseaux sauvages et conséquences pour la dynamique spatiale des virus Influenza A

- Modélisation épidémiologique de la circulation des souches en zone d'endémie du virus H5N1 HP (Asie du Sud-Est)