Dosimetry Tools for Field Studies

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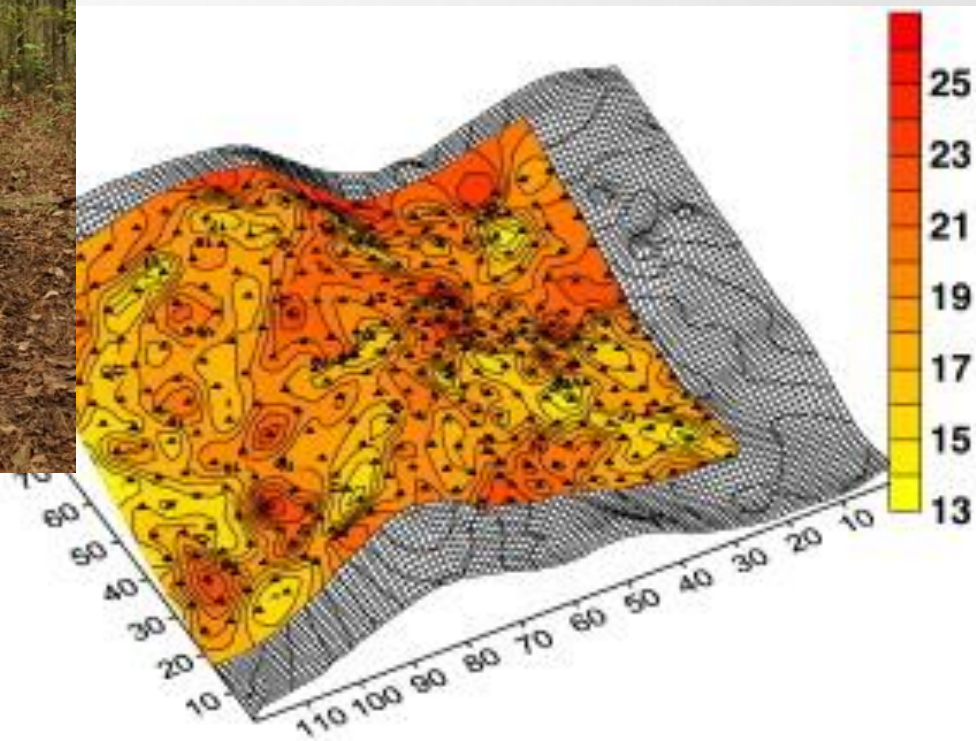
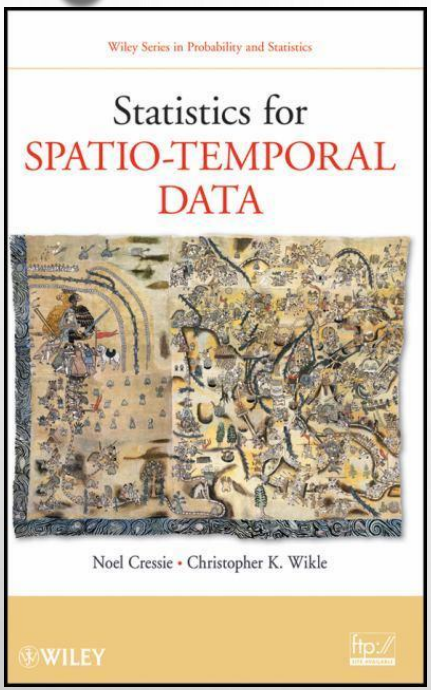
James Beasley Savanah River Ecology Laboratory, USA



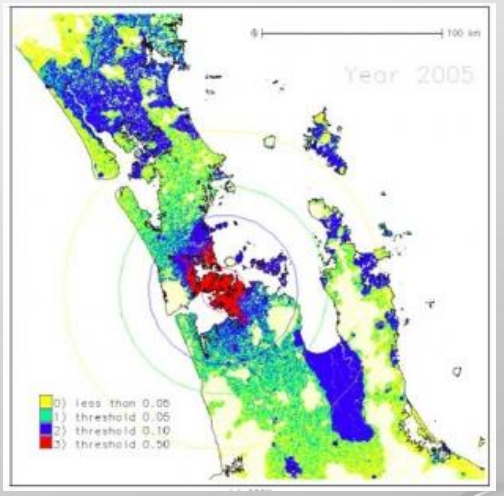
Dosimetry Tools

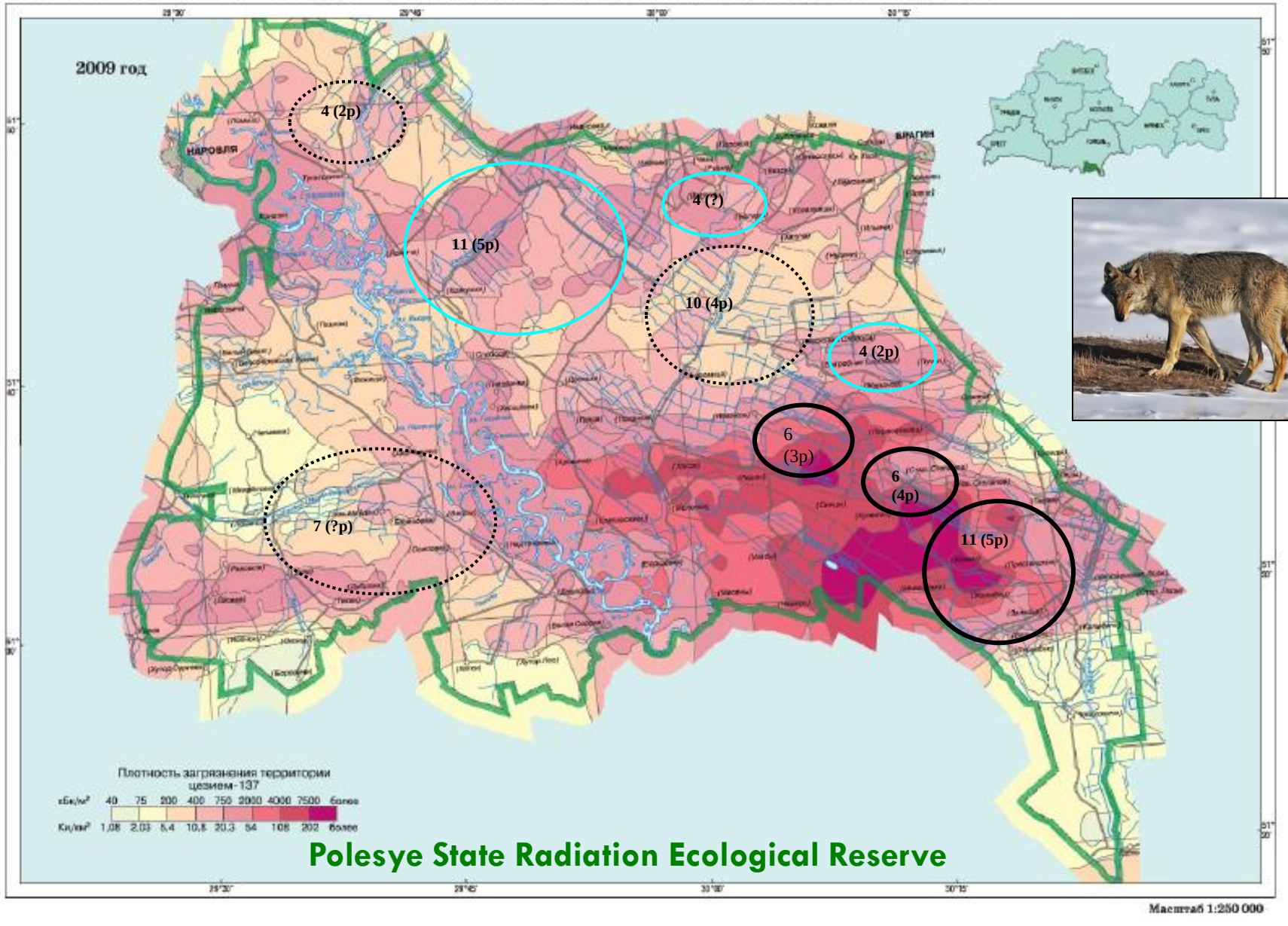
- Passive TLDs
- Electronic TLDs
- Reciprocal Translocations of Chromosomes
- Electronic Paramagnetic Resonance
- Whole-body Assay
- Voxel Phantoms
- GPS-Dosimeter

Accurate quantification of absorbed dose is among the greatest challenges in field research of free-ranging animals, and it is the measurement most lacking in many of the controversial papers regarding radiation effects to wildlife at Chernobyl



Current wildlife dose models, and associated field measurements, do not assess wildlife exposure realistically because they do not consider the spatial and temporal variability in habitat use, or the large heterogeneity in levels of contamination




2009 год
4 (2p)
11 (5p)
4 (?)
10 (4p)
4 (2p)
6
(3p)
6
(4p)
11 (5p)
7 (?p)
Плотность загрязнения территории
цезием-137
кБк/м² 40 75 200 400 750 2000 4000 7500 более
Ки/км² 1,08 2,03 5,4 10,8 20,3 54 108 202 более
Polesye State Radiation Ecological Reserve
Масштаб 1:250 000

2160 km2

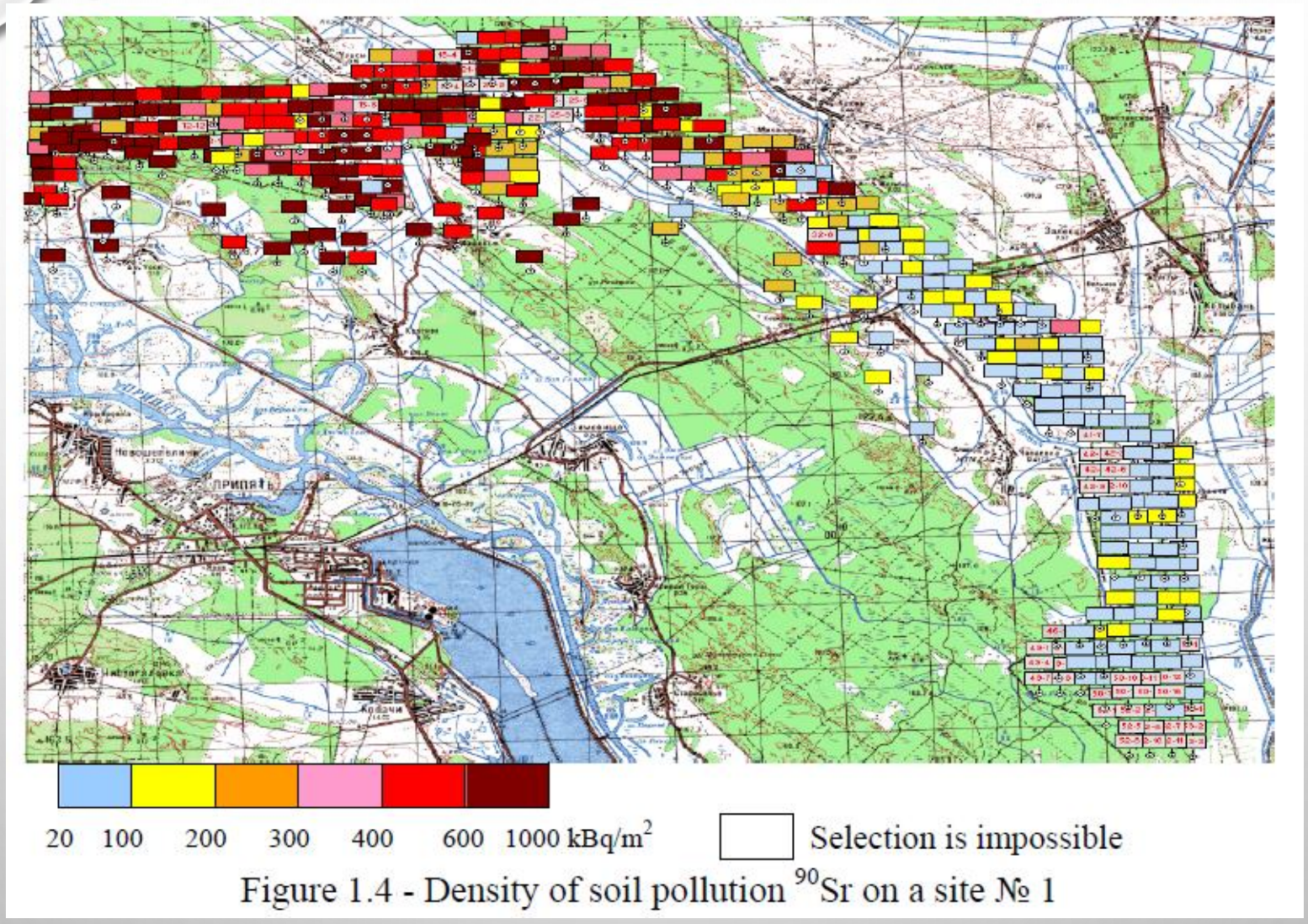


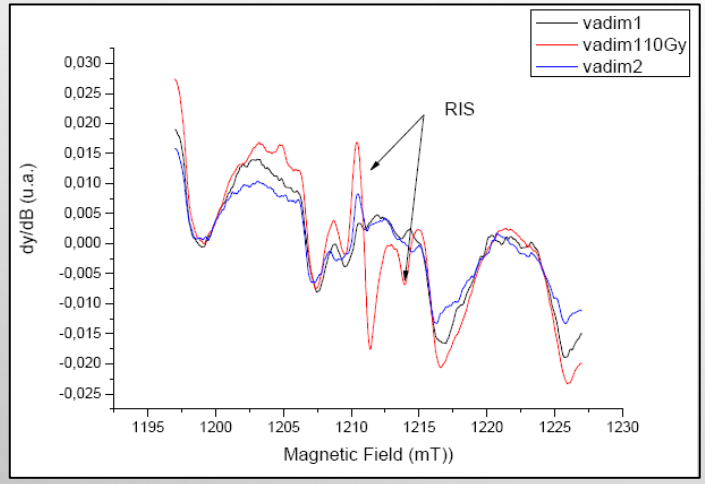
Figure 1.4 - Density of soil pollution ^{90}Sr on a site № 1

(from Brown et al. 2012)

Two methods for estimating an animal's life time dose

Electronic Paramagnetic Resonance (EPR) of tooth enamel

Francois Trompier, IRSN



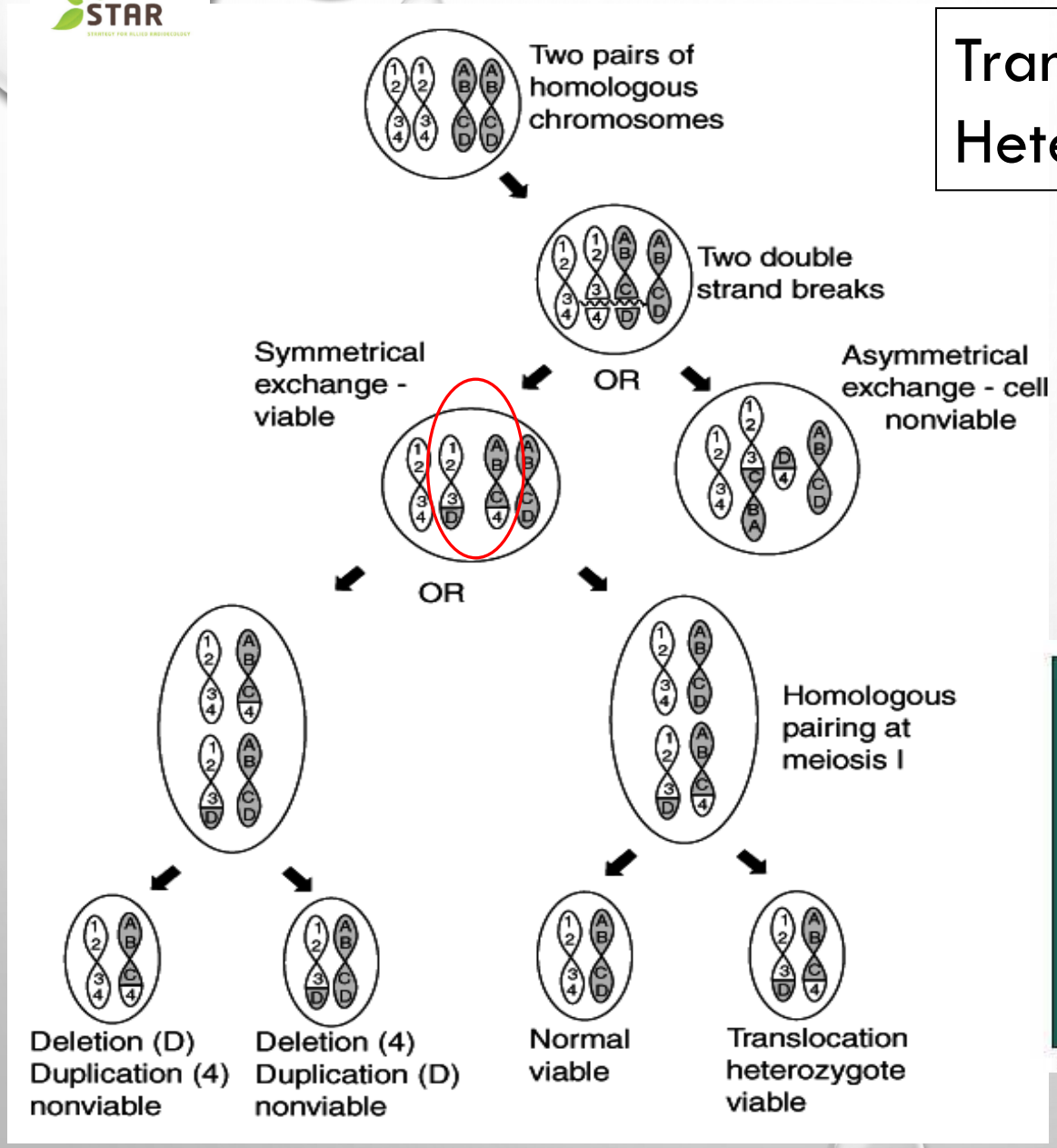
EPR spectra in Q-band of two wolf teeth samples (5 mg).
Sample Vadim-1 was irradiated at 10 Gy to identify the RIS

Reciprocal Translocations

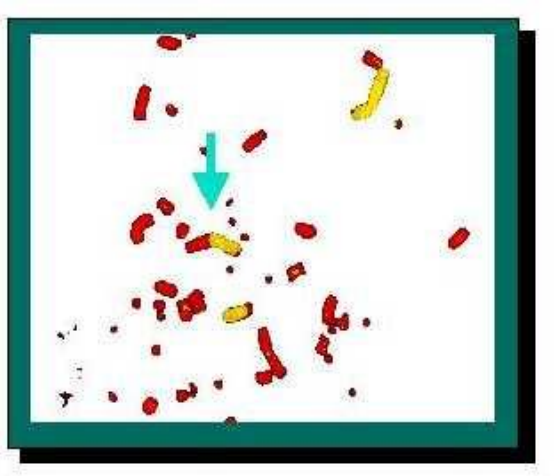
- An indication of an organisms integrated life-time dose
- Not lethal to cell
- Frequencies of RTs accumulate with dose
- Result in relocation of chromosome sections

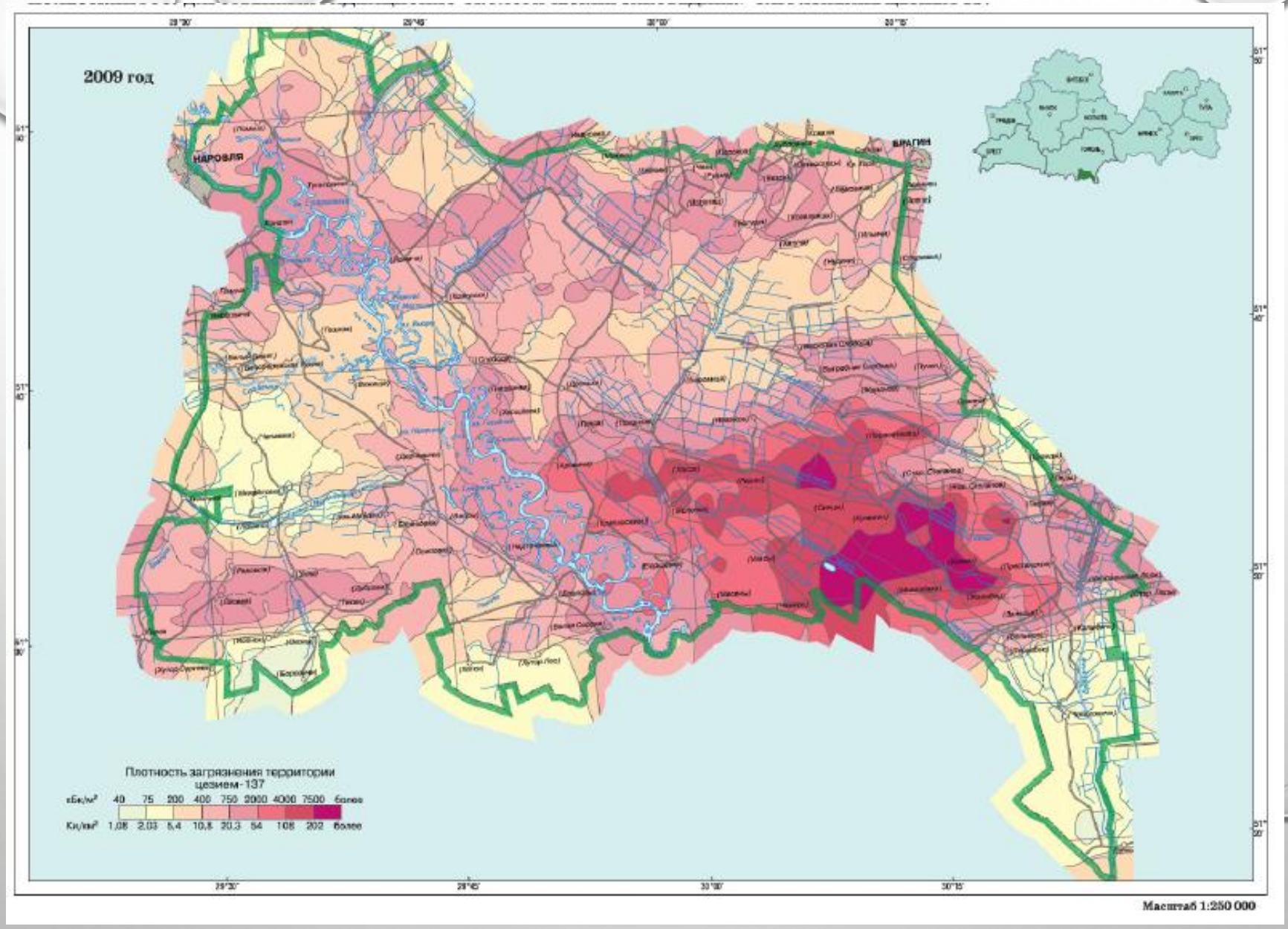
Ulsh et al. 2003. Environmental biodosimetry: a biologically relevant tool for ecological risk assessment and biomonitoring. JER 66:121-139.

Translocation Heterozygosity



50 % reduction in reproductive success

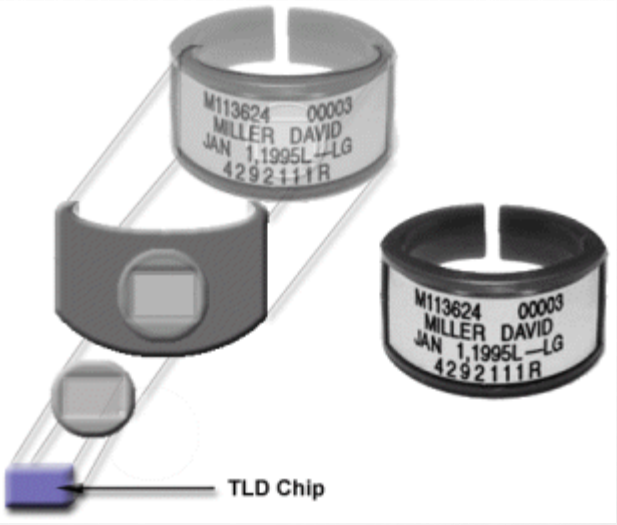




Polesye State Radiation Ecological Reserve

2160 km2

Thermoluminescent Dosimeters (TLDs)…

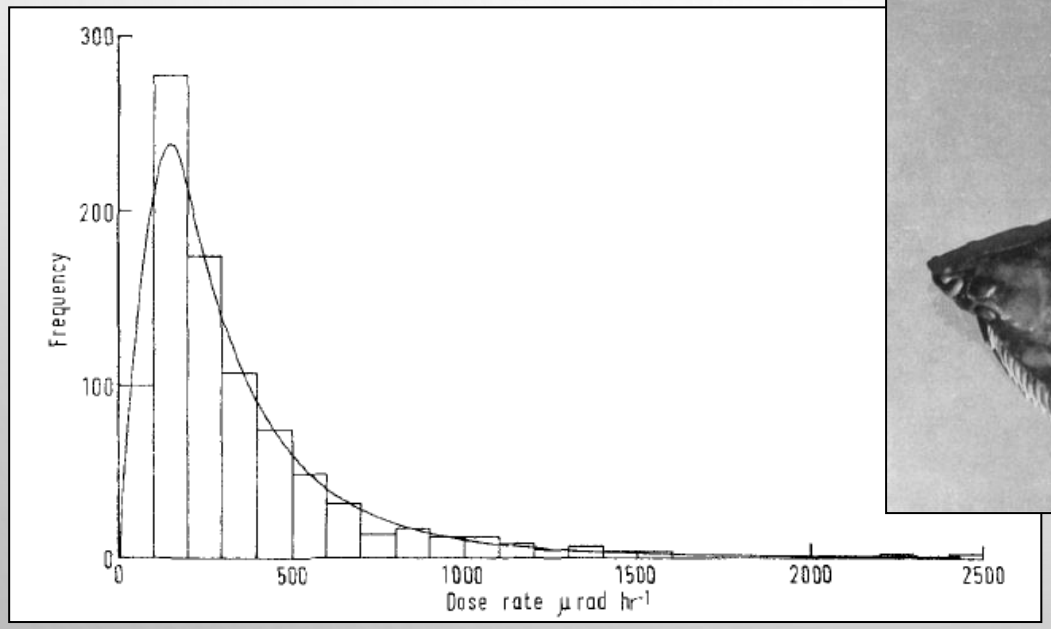


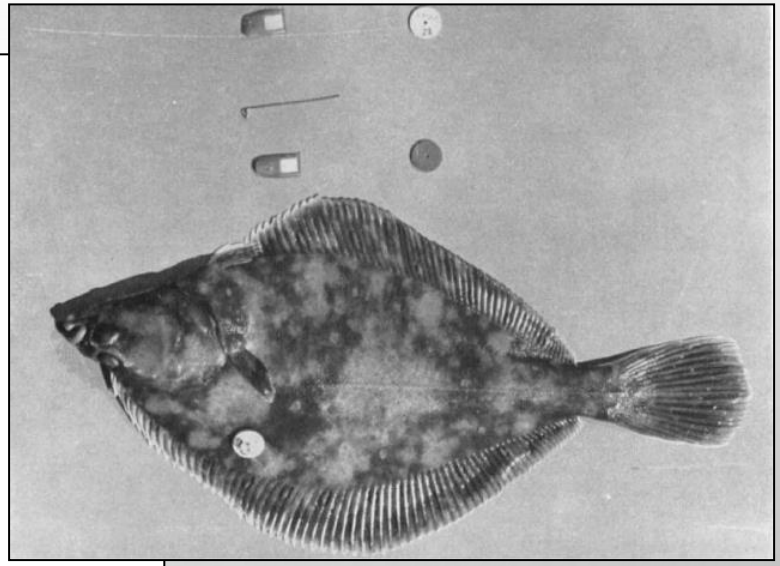
Health Physics Pergamon Press 1973. Vol. 25 (August), pp. 115–121. Printed in Northern Ireland

THE RADIATION DOSE RECEIVED BY PLAICE (*PLEURONECTES PLATESSA*) FROM THE WASTE DISCHARGED INTO THE NORTH-EAST IRISH SEA FROM THE FUEL REPROCESSING PLANT AT WINDSCALE

D. S. WOODHEAD
Ministry of Agriculture, Fisheries and Food, Fisheries Radiobiological Laboratory,
Hamilton Dock, Lowestoft, Suffolk, England

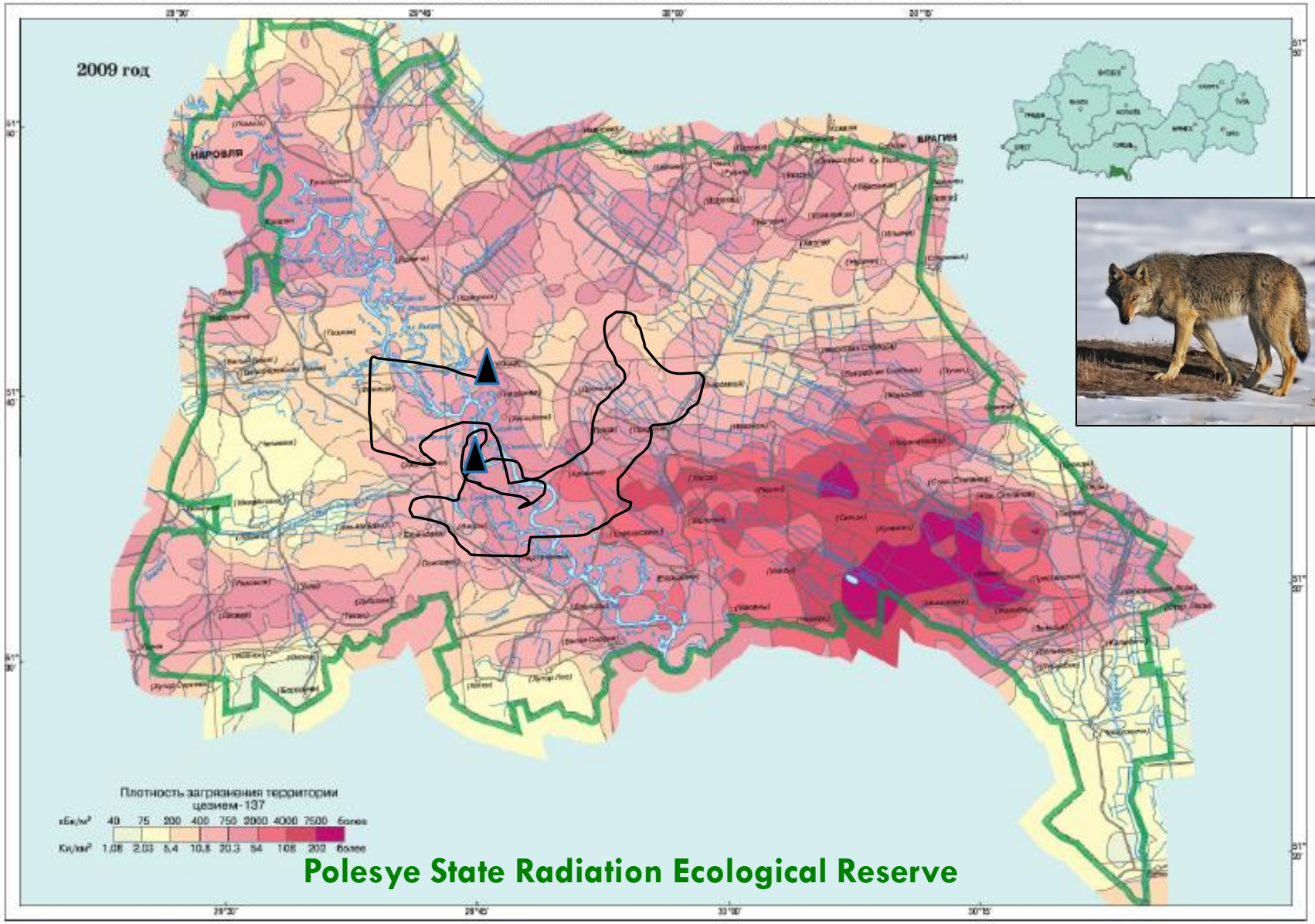
(*Received* 17 *July* 1972; *in revised form* 3 *January* 1973)





3580 fish captured, tagged and released; 29% recaptured

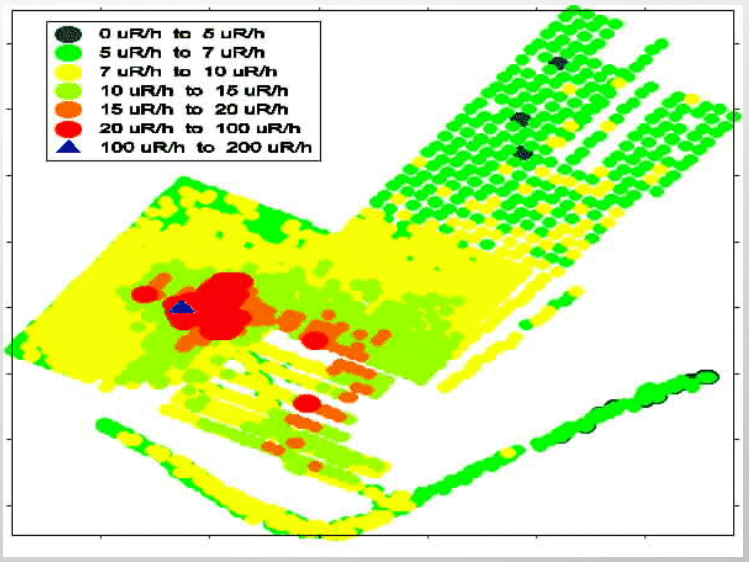
With programed release of the collar … so that it disconnects from the animal

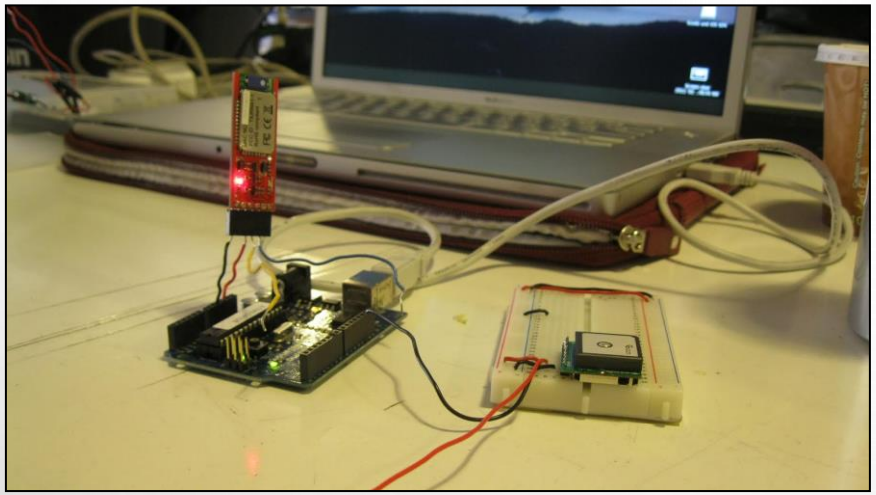


Polesye State Radiation Ecological Reserve

Electronic Dosimeter

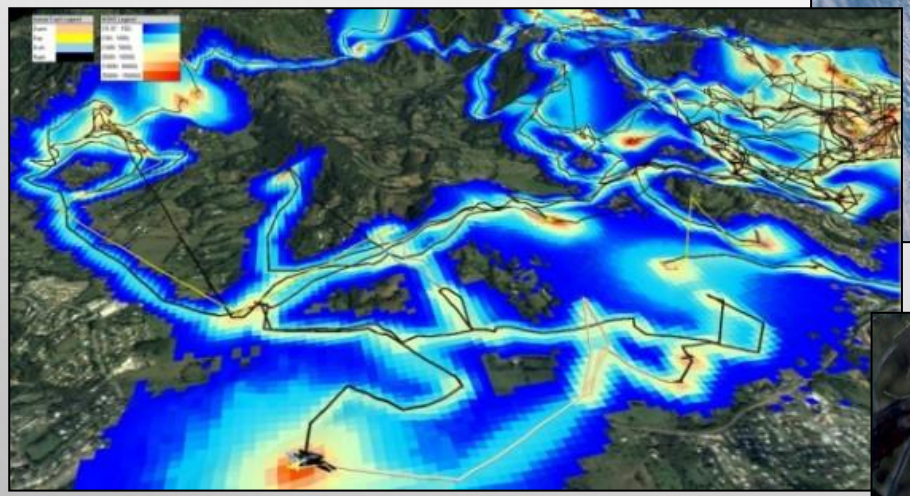
GPS-electronic dosimeter combinations already exist in situations where size of the units, battery life, and environmental conditions are not factors





The challenge of our research was to: 1) miniaturize the components so that they can be attached to an animal; 2) ensure that the two units communicate properly with each other; 3) have sufficient battery life; and 4)… withstand very harsh environmental conditions.

We have produced **a new scientific tool** that permits an animal's location and short-term integrated dose to be periodically sent, via satellite, to the investigator.



Test results of three GPS-dosimeter units identically exposed within a ^{60}Co calibration facility.

Photo 1: Black GPS-Dosimetry Collar on Calibration Stand

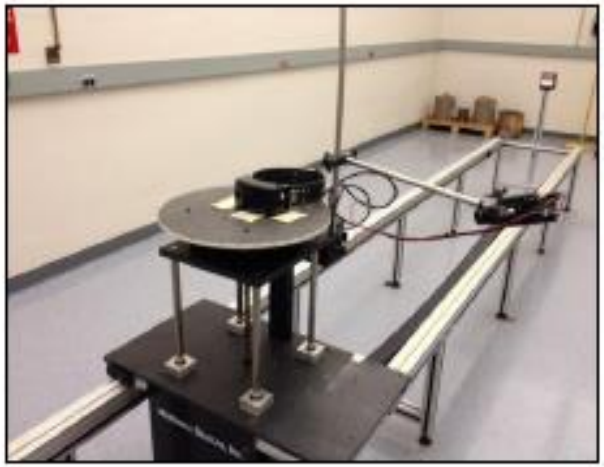
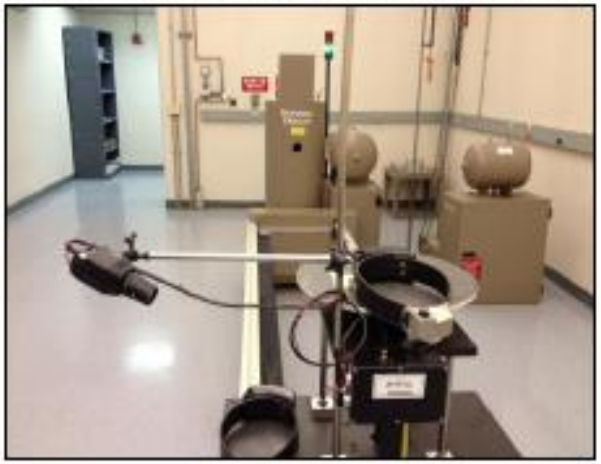


Photo 2: GPS-Dosimetry Collar on Calibration Stand, facing the Gamma Souce (under yellow square at far end of the room)



Results:

	collar 13650		collar 13651		collar 13652							
Test Exposure	Integrated Dose (uSv)	Measured uSv	Integrated Dose (uSv)	Measured uSv	Integrated Dose (uSv)	Measured uSv	Mean of 3	Std Dev.	CV	2 Std. Dev.	Mean -2 Std. Dev.	Mean + 2 Std. Dev.
pre-test reading on dosimeter	134		135		159							
reading after 10 uSv	146	12	147	12	170	11	11.7	0.6	4.9	1.2	10.5	12.8
pre-test reading on dosimeter	147		147		170							
reading after 25 uSv	175	28	176	29	202	32	29.7	2.1	7.0	4.2	25.5	33.8
pre-test reading on dosimeter	175		176		202							
reading after 50 uSv	232	57	232	56	259	57	56.7	0.6	1.0	1.2	55.5	57.8
pre-test reading on dosimeter	233		232		259							
reading after 5 uSv	238	5	238	6	266	7	6.0	1.0	16.7	2.0	4.0	8.0

1/22/2014 10 pm
© 2013 Google
Google earth
1994
Imagery Date: 12/18/2011 33°15'24.61" N 81°43'28.62" W elev 143 ft eye alt 8099 ft

Comparison of GPS-Dosimeter readings

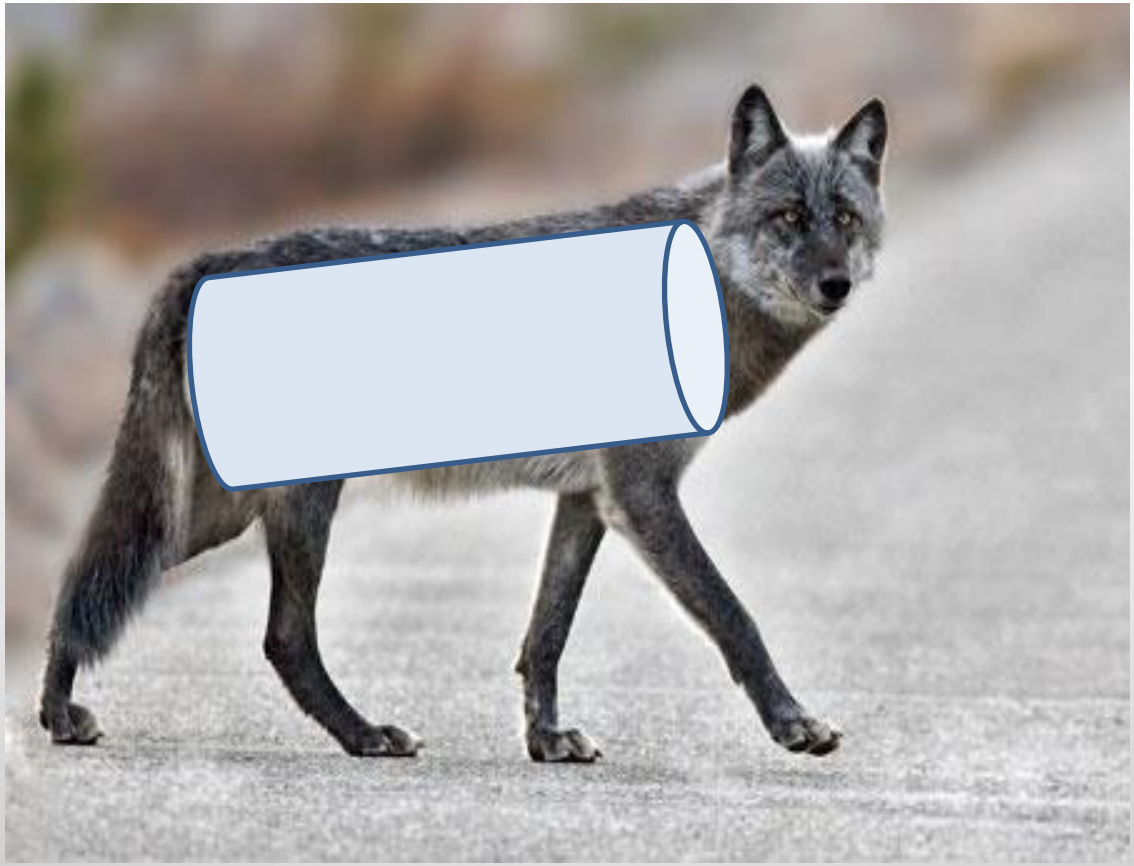
Deployed for 45 days on three hogs from the same sounder

	Collar 13650				Collar 13651				Collar 13652			
Days Elapsed	**Date**	**Time**	**uGy**	**Dose received**	**Date**	**Time**	**uGy**	**Dose received**	**Date**	**Time**	**uGy**	**Dose received**
	1/6/2014	17:00	298		1/6/2014	17:00	284		1/6/2014	17:00	314	
45	2/20/2014	16:00	384	86	2/20/2014	16:00	365	81	2/20/2014	16:00	398	84

Calibration and Interpretation of Field Dosimetry ??

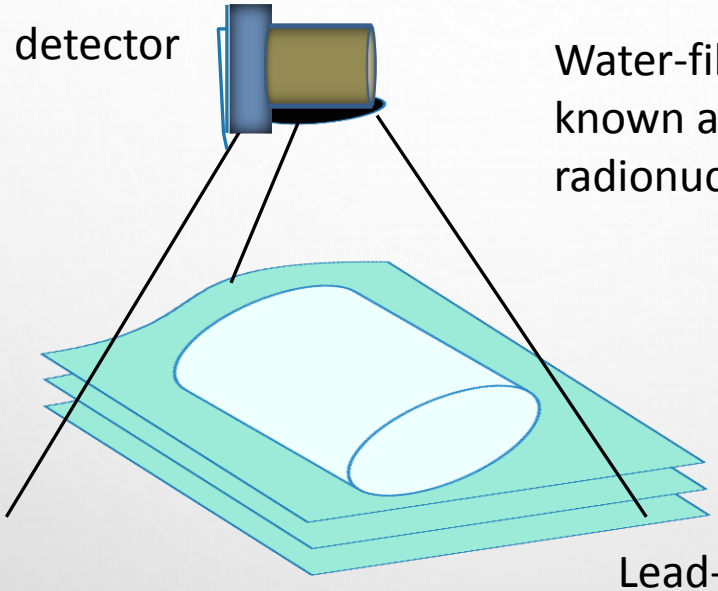
Whole-body counting humans for radiation

Cylinders for calibration phantoms



Wolf represented by cylinders filled with calibrated liquids

Radiation detector

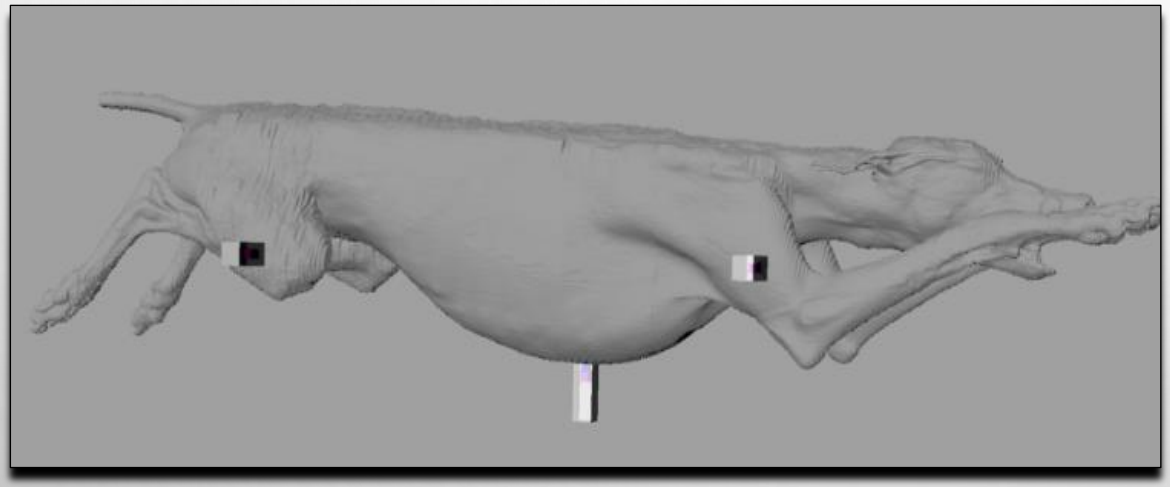


Water-filled wolf phantom containing known activity concentrations of radionuclides

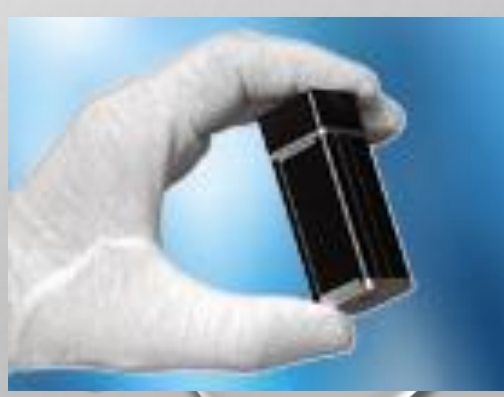
Lead-lined blankets

Dr. David Broggio, IRSN, adapted a voxel phantom of a large dog, produced by a Canadian research team, to the physical dimensions of a wolf using Rhinoceros3D modelling software.

G.H Kramer *et al. The HML's new voxel phantoms: two human males, one human female, and two male canines*. Health Phys. 103(6):802-807 (2012).



silicon detector of Cd, Zn and Te composition



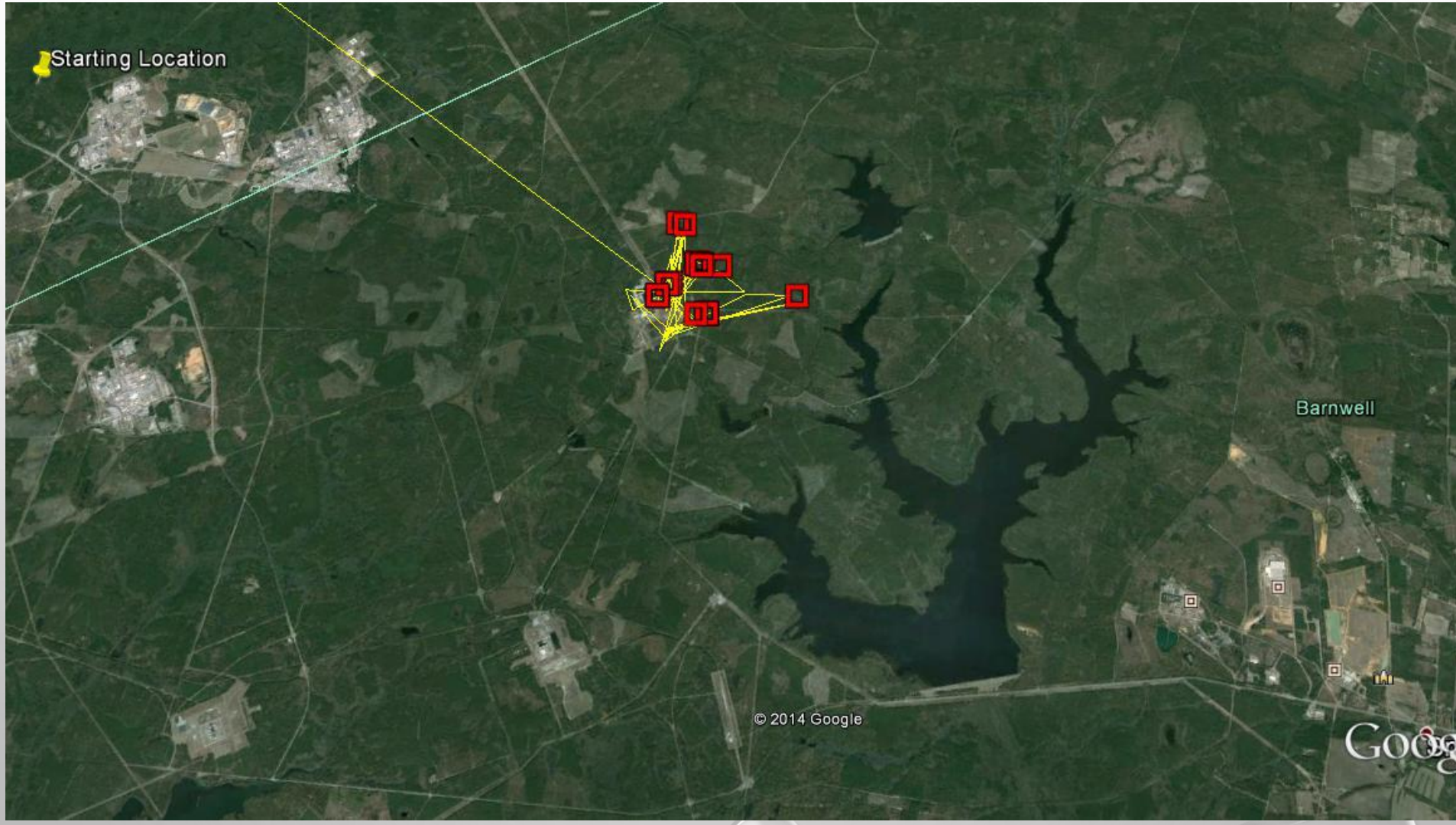
Used a rough model of the CZT detector and Monte Carlo calculations to:

- calculate counting efficiencies (*i.e.* calibration factors) for ^{137}Cs;
- study the dependency of counting efficiencies as a function of counting positions and wolf weight;
- deduce the expected counting rate and counting time needed to obtain a reliable statistics;
- design a calibration phantom;
- discuss a preliminary design of a collimator.

2014-05-22 4:32:20 PM M 1/1
103°F
RECONYX

2014-05-22 7:54:16 AM M 1/1 72°F
PC900 PROFESSIONAL
RECONYX

GEORGIA


Starting Location
Barnwell
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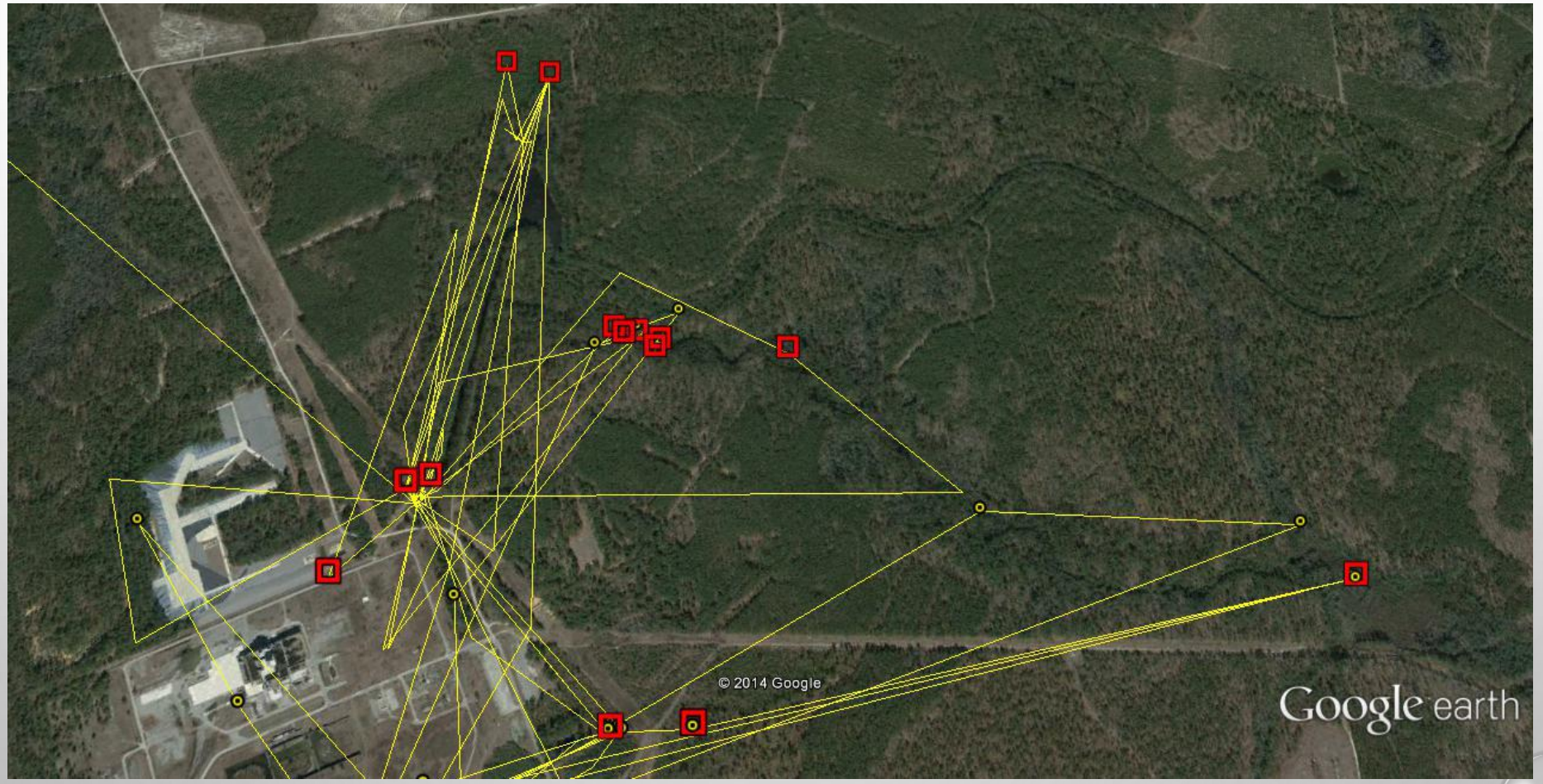
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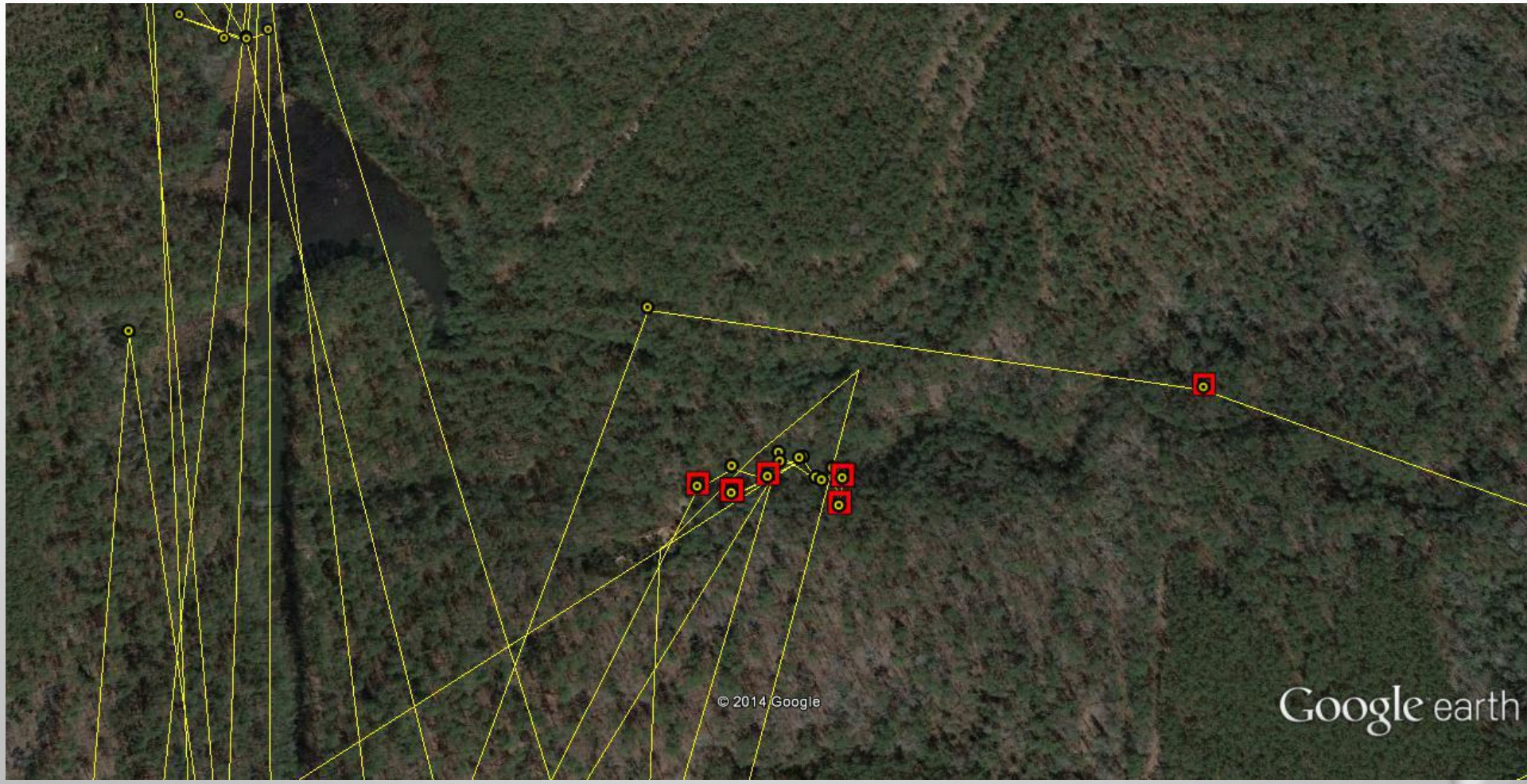
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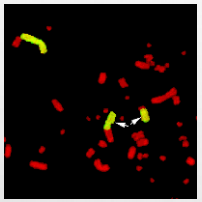
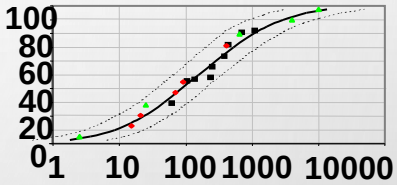
The GPS-Dosimter Tool will help make other related research possible

understand the sub-lethal effects of chronic, low-dose exposures



develop bioindicators of radiation exposure



determine the effects from multi-generational exposures

develop environmental benchmarks, below which risks are acceptable

reduce uncertainties in wildlife dose models

Collaborators

T. Hinton-project coordinator, K. Beaugelin-dose models, and J-M Metivier-GIS;
F. Trompier- external dosimetry; D. Broggio-internal dosimetry

Vectronic Aerospace, Berlin, Germany -- GPS

Mirion Technologies, Lamanon, France -- Electronic Dosimeter

Norwegian Radiological Protection Authority, J. Brown

Belarus National Academy of Sciences

Savannah River Ecology Laboratory, Univ. of Georgia, USA

Polesye State Radioecological Reserve — Y. Bondar and staff

Alexander Bundtzen, Berlin, Germany; Independent logistics expert in Belarus

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