ABIM Lucerne 2009
Presented by Denise Munday

The use of *Bacillus thuringiensis israelensis* in vector control programmes (mosquitoes)

Acknowledgements: PD Dr. habil. Norbert Becker, Uni. Heidelberg
Dr. Peter DeChant, Valent BioSciences Corp.

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Is vector control necessary in Europe?

- to increase or maintain ***quality of life*** of citizens

- to provide ***equal living conditions*** for all citizens

- to ***avoid or minimize health threats*** to humans and animals (diseases or allergic reactions)

- to ensure a healthy ***socio-economic development***

- to ensure ***income for enterprises*** in mosquito infested areas (e.g. hotels and restaurants touristic areas)

Nuisance and Life quality!

Biting rates >1500 mosquitoes per person over 2 minutes

Consequences:

Impossible to spend time outdoors from late afternoon;

Health risks significant in sensititive subjects;

Property prices devalued;

Loss of economic power for the affected region;

Mosquitoes as vectors in Europe

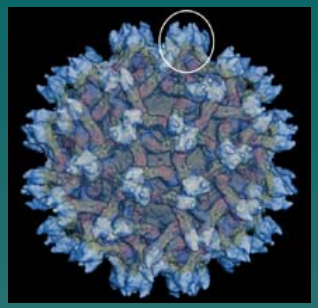
Risk of resurgence of diseases thought to be eradicated

Malaria

In Europe eradicated after WW II
– More than 10.000 Malaria cases are imported to Europe mainly from Africa
– High risk as all anopheline vectors are still present
- climatic change can increase risk

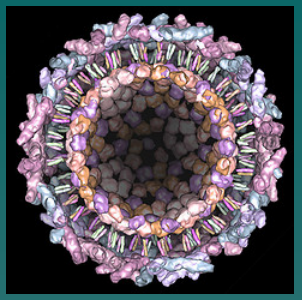
Dengue

In 20th century dengue epidemics in Europe, e.g. Spain, Italy, Austria and devastating epidemic in Greece 1927/28 – 1 Mill. cases with 1500 fatalities



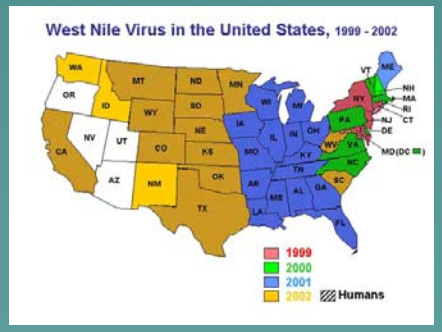
Mosquitoes as vectors in Europe

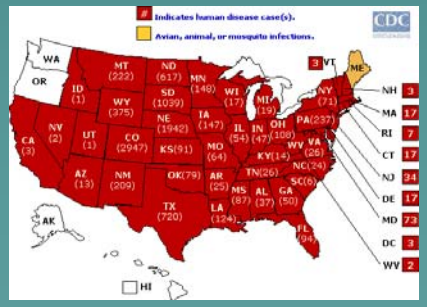
Emerging diseases



Chikungunya Virus

First European epidemic of this tropical disease was seen in Ravenna, IT in 2007- about 300 cases with 1 fatality



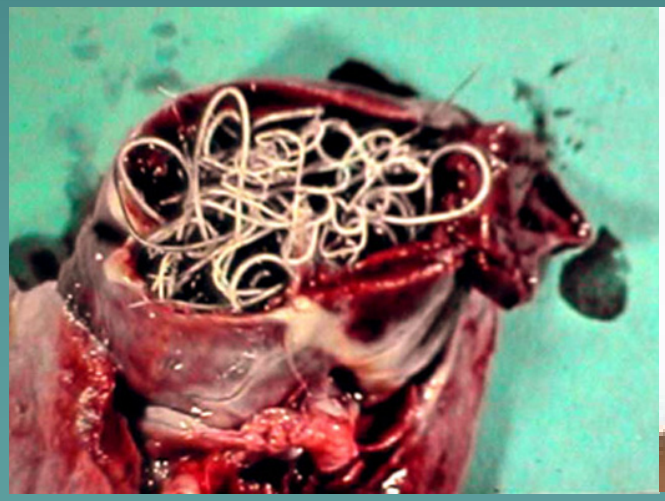


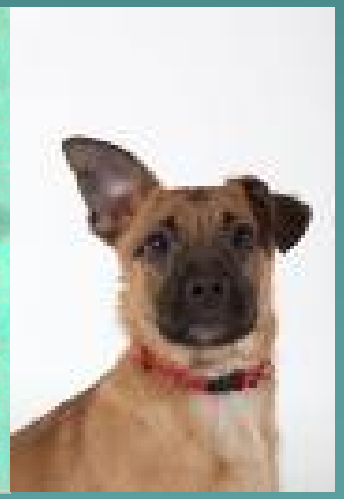
West Nile Virus

Outbreaks in Romania, Czech Republic, Russia, Israel and Italy

USA: first cases 1999; rapidly spread across the continent in the following 5 years; 10.000 cases 2003 and 264 fatalities

Consequences of Mosquito and black fly mass occurrence for livestock in Europe





Vectors transmit diseases that kill livestock (cows, horses, sheeps and pigs);

Stress and inflamations reduce the meat and milk production significantly

The heartworm *Dirofilaria immitis* is transmitted by mosqutitoes and widely endemic in the mediterranean area, e.g. Italy in the Po plain.

Now in Germany autochthonous cases are also reported.

Mosquito Control Organisations in Europe

European Abatement Districts

Area	Founded	Surface (ha)
Croatia	2003	20.000
France		
EID-Mont	1958	350.000
EID-Atl.	1963	100.000
EID-Rhon	1966	250.000
EID-Alsace	1984	10.000
SIAAP	1992	2.000
Germany	1976	600.000
Greece	1997	30.000
Hungary	2001	300.000
Italy		
Bologna	1987	10.000
Emilia-R.	1991	10.000
Piedmont	1995	250.000
Spain		
Roses Bay	1982	8.000
Baix Llobr.	1983	25.000
Ebro	1991	32.000
Huelva	1985	130.000
Serbia	1976	50.000
Slowenia	1992	100
Sweden	2000	20.000
Switzerland	1988	10.000

22 Organisations – 2.3 Mill. Hektars

Weapons to fight mosquitoes

Physical control

- environmental management
  (e.g. source reduction);
- surface layers and polystyrene beads
- reduction of human vector contact
  (e.g. use of bednets, repellents);

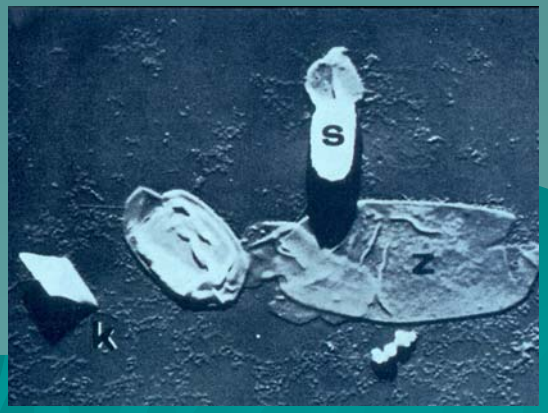
Chemical control

- adulticide spraying e.g. pyrethroids
- larviciding e.g. temephos

Biological control

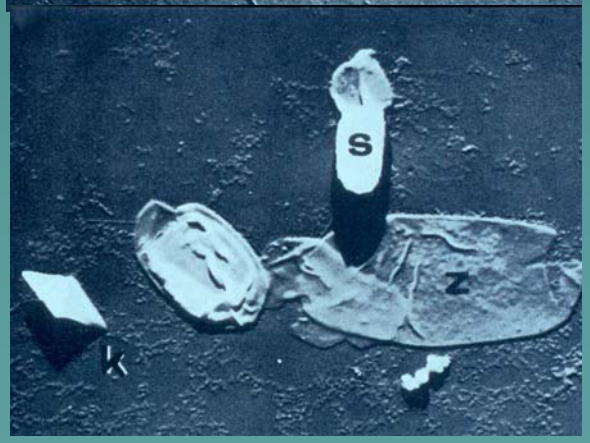
- fish, invertebrates, birds
- microbial control agents

Bacillus thuringiensis israelensis
Bacillus sphaericus



Selectivity

Breakthrough in biological control of mosquitoes



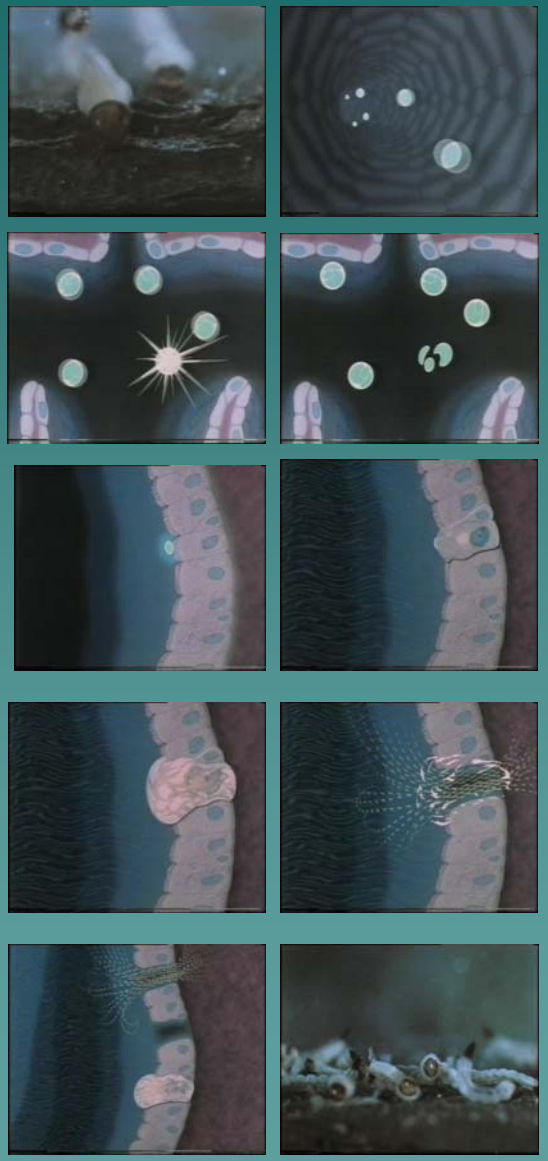
Discovery of Bti in the Negev Desert by Dr. Yoel Margalith in August 1976

Soil bacteria can be found in almost each habitat, part of the natural environment

Toxins of B.t.i. are as effective as chemicals

Unique mode of action

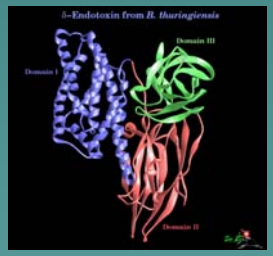
Selectivity derives from various factors

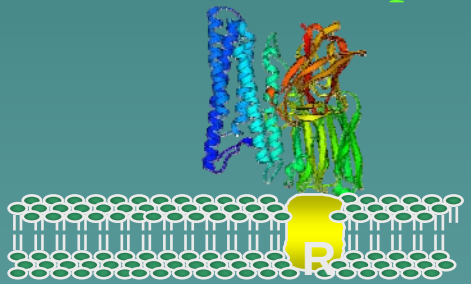


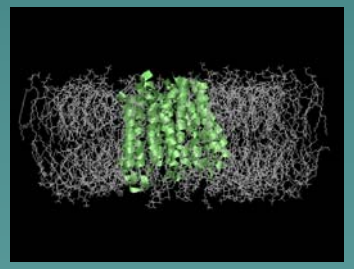
1. Ingestion of the protein crystal

2. Activation of the toxins by proteases

3. **Binding** of the toxins to specific receptors

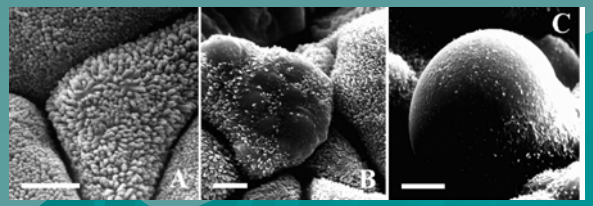






4. Pore formation, Swelling, bursting

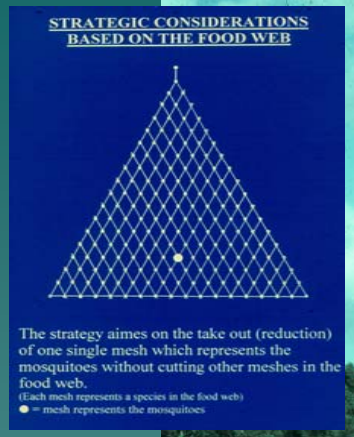
5. Death



Taxa not affected by *B. thuringiensis israelensis*

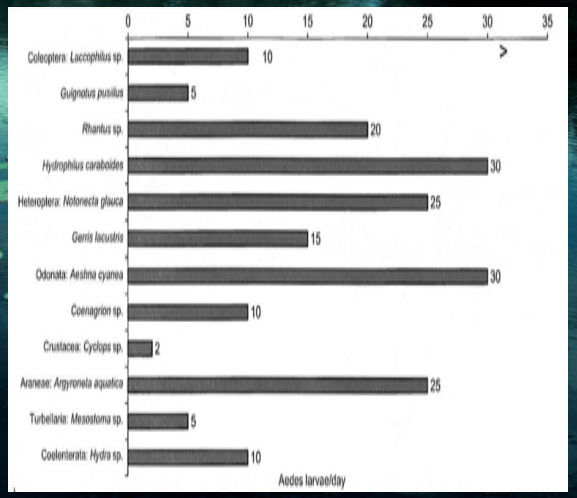
TAXA	DOSAGE (ppm)	SPECIES
Cnidaria	100	Hydra sp.
Turbellaria	180	Dugesia tigrina, Bothromesostoma personatum
Rotatoria	100	Brachionus calyciflorus
Mollusca	180	Physa acuta, Aplexa hypnorum, Galba palustris, Anisus leucostomus, Bathyomphalus contortus, Hippeutis complanatus, Pisidium sp.
Annelida	180	Tubifex sp., Helobdella stagnalis
Acari	180	Hydrachnella sp.
Crustacea	180	Chirocephalus grubei, Daphnia pulex, Daphnia magna, Ostracoda, Cyclops strenuus, Gammarus pulex, Asellus aquaticus, Orconectes limosus
Ephemeroptera	180	Cloeon dipterum
Odonata	180	Ischnura elegans, Sympetrum striolatum, Orthetrum brunneum
Heteroptera	180	Micronecta meridionalis, Sigara striata, Sigara lateralis, Plea leachi, Notonecta glauca, Ilyocoris cimicoides
Coleoptera	180	Hyphydrus ovatus, Guignotus pusillus,Coelambus impressopunctatus, Hygrotus inaequalis, Hydroporus palustris, Ilybius fuliginosus, Rhantus pulverosus, Rhantus consputus, Hydrobius fuscipes, Anacaena globulus, Hydrophilus caraboides,
Trichoptera	180	Limnophilus sp., Phryganea sp.
Fish	180	Esox lucius, Cyprinus carpio, Perca fluviatilis
Amphibian (larvae)	180	Triturus alpestris,Triturus vulgaris, Triturus cristatus, Bombina ariegata, Bufo bufo, Bufo viridis, Bufo calamita, Rana esculenta, Rana temporaria

Conservation of the Biodiversity



Goal: integration of the *protection of humans* against mosquitoes and the protection of *NATURE*

USE THE POWER OF NATURE!



Philosophy of larvicides

Larval control is the most cost-effective

Relatively small areas need treating

Concentrated

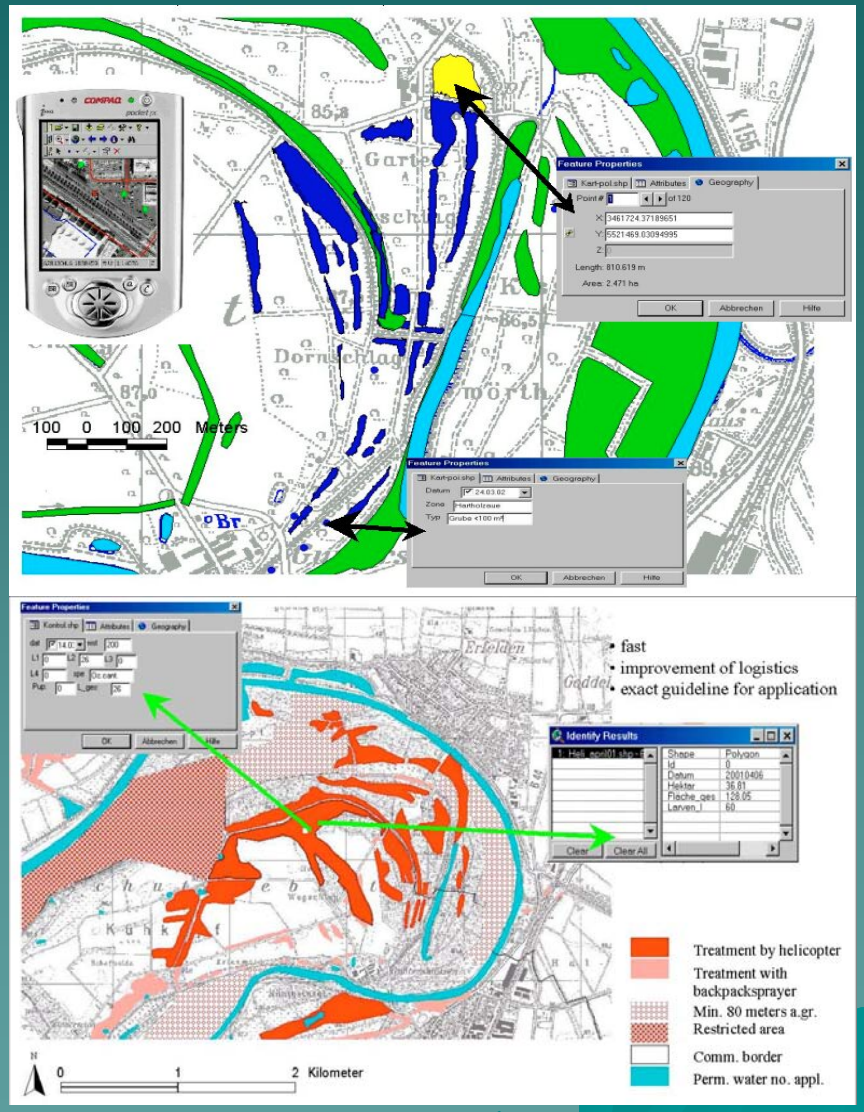
Immobile

Accessible

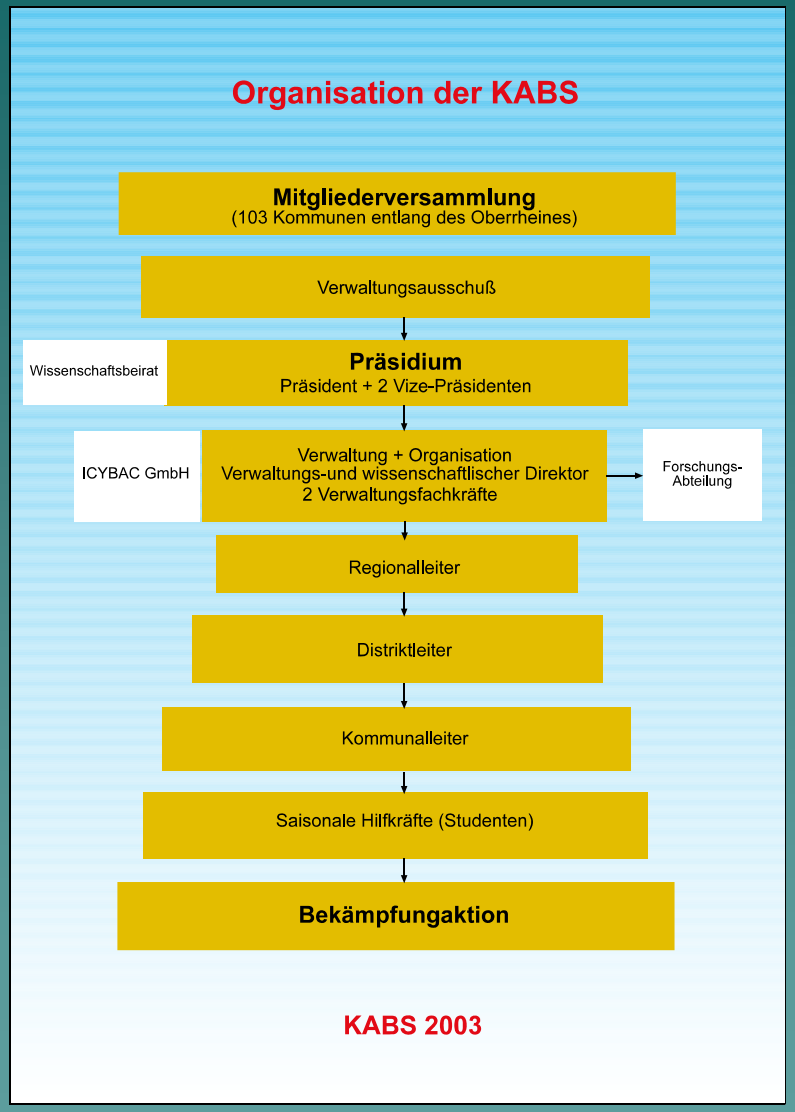
PREREQUISITES FOR THE IMPLEMENTATION OF BIOCONTROL WITH *B.t.i.*

1. ***Entomological studies*** (species composition, phenology)
2. ***Precise Mapping*** (ecological mapping)
3. Assessment of the ***effective dosage***
4. Adaptation of the ***application techniques***
5. Design of the ***control strategy***
6. Training of the ***field staff***

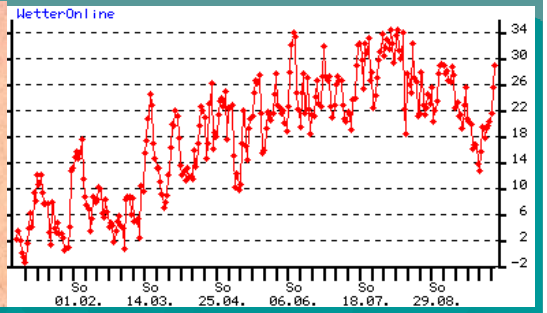
Targetting through GIS/GPS Mapping



Functioning Organisations and Infrastructure



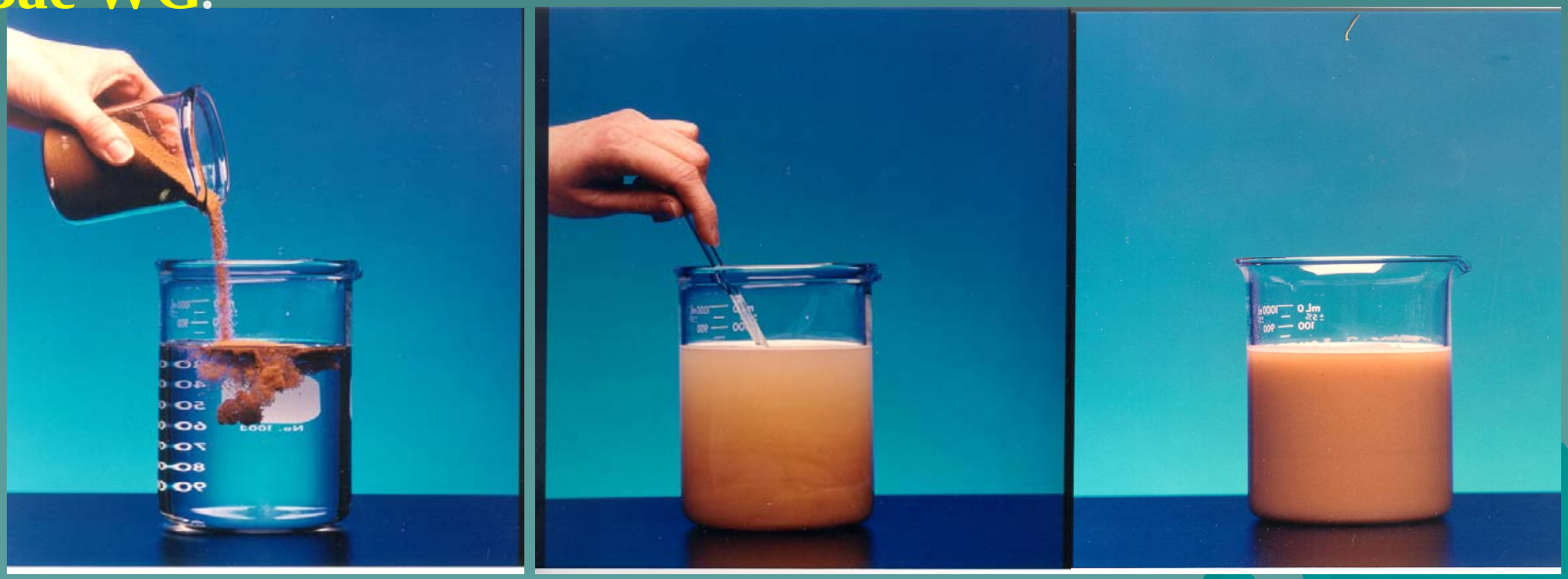
- 5 Regional leaders
- 8 District leaders
- Community leaders
- >200 Seasonal co-workers



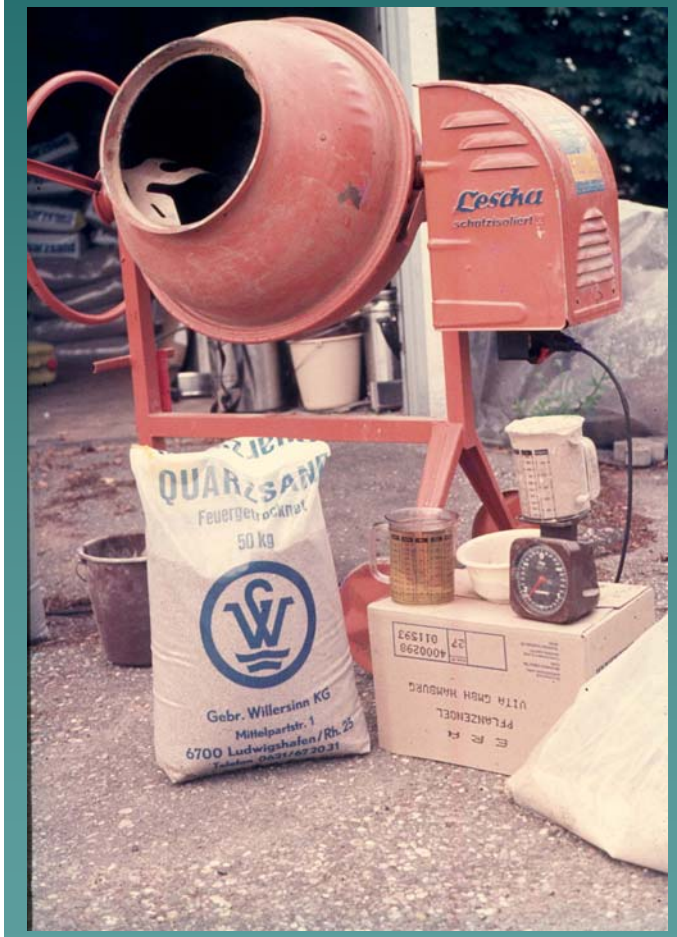
Adequat formulations

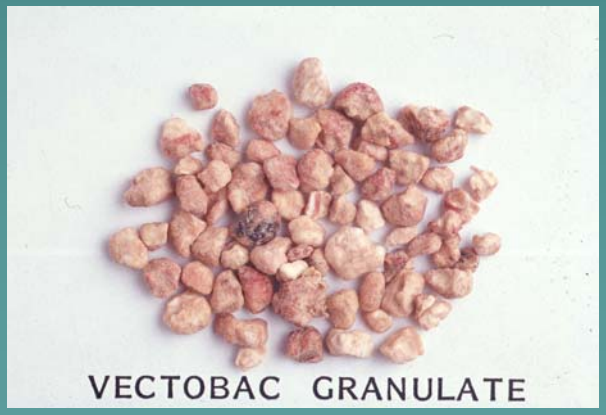
Powders, granules and liquids for different circumstances.

VectoBac WG.

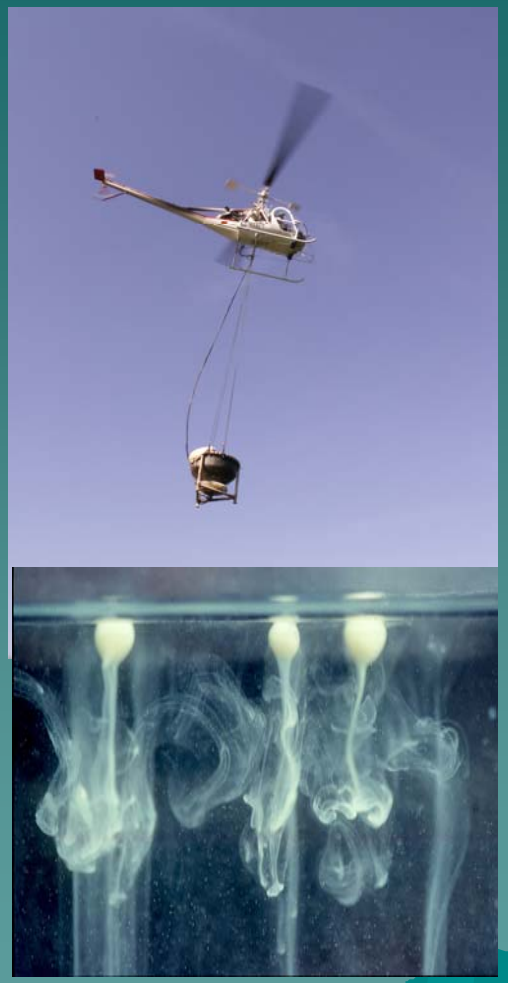


Various VectoBac Granule Formulations





Production and application of Ice granules



Advanced application techniques

Ground application by knap sack sprayers

Mixing the control agent with water

application

Appr. 30% of the total area by ground application

Why aerial Applications?

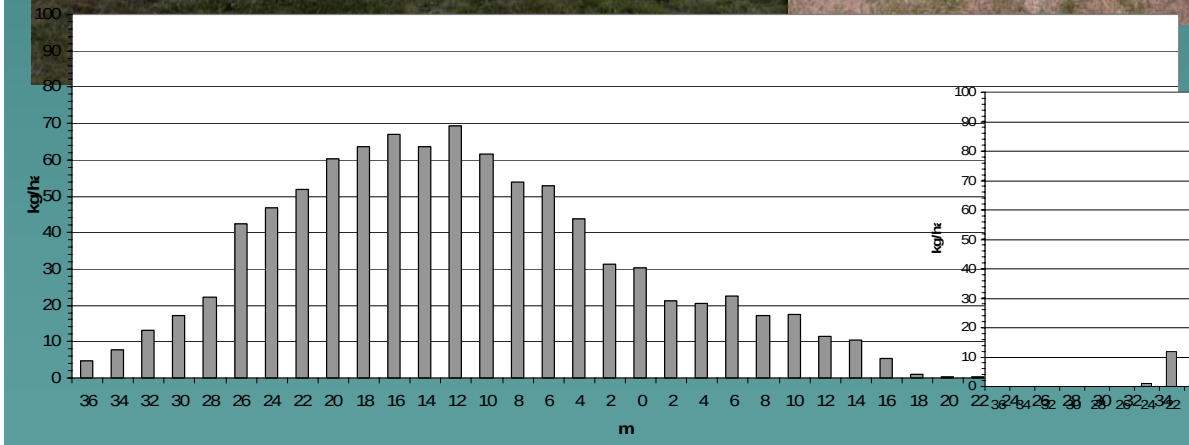
Huge densely vegetated areas – not accessible by ground

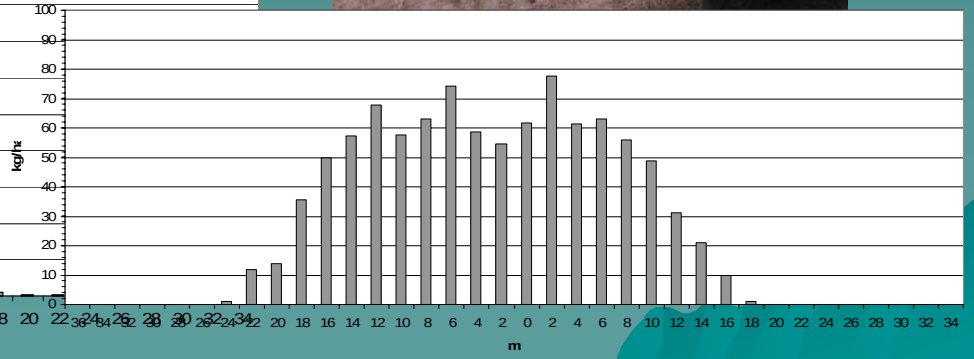
Several hundred thousands of hectars of rice fields

Usually dense vegetation –ground appl. impossible

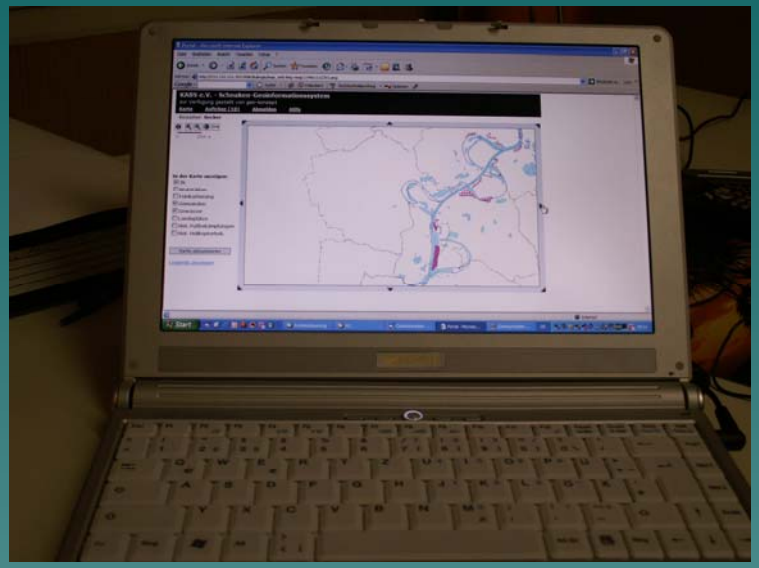
Huge areas of salt marshes – aerial Treatment essential

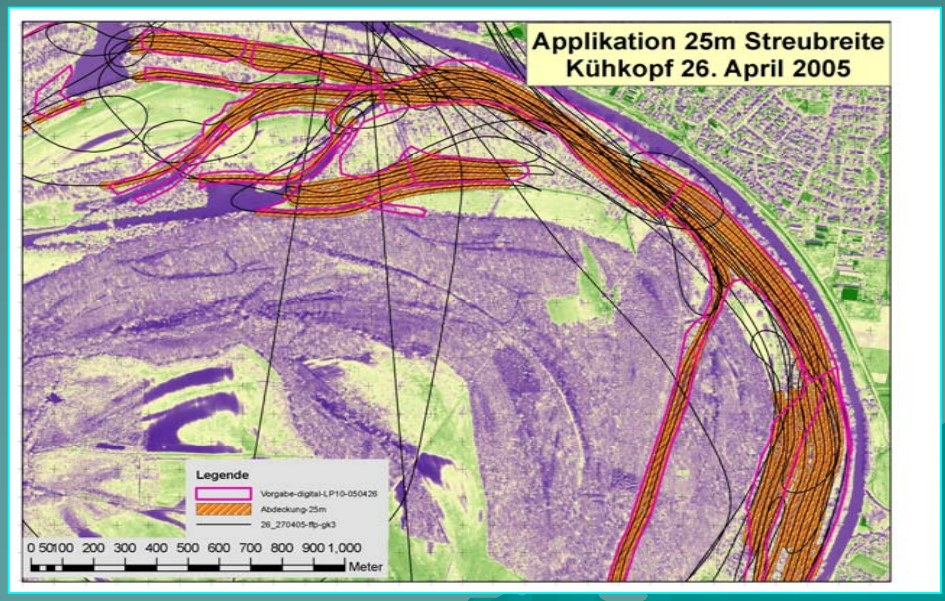
Optimising the Applications



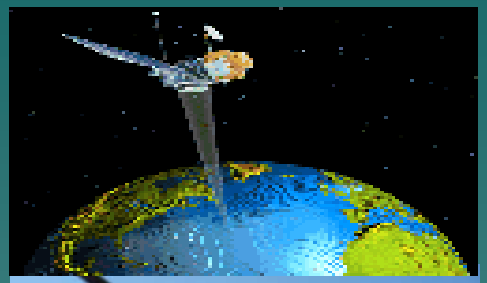


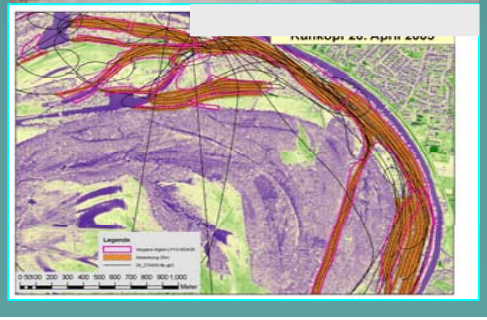
Web-GIS increases efficiency and accuracy of the Appliatio





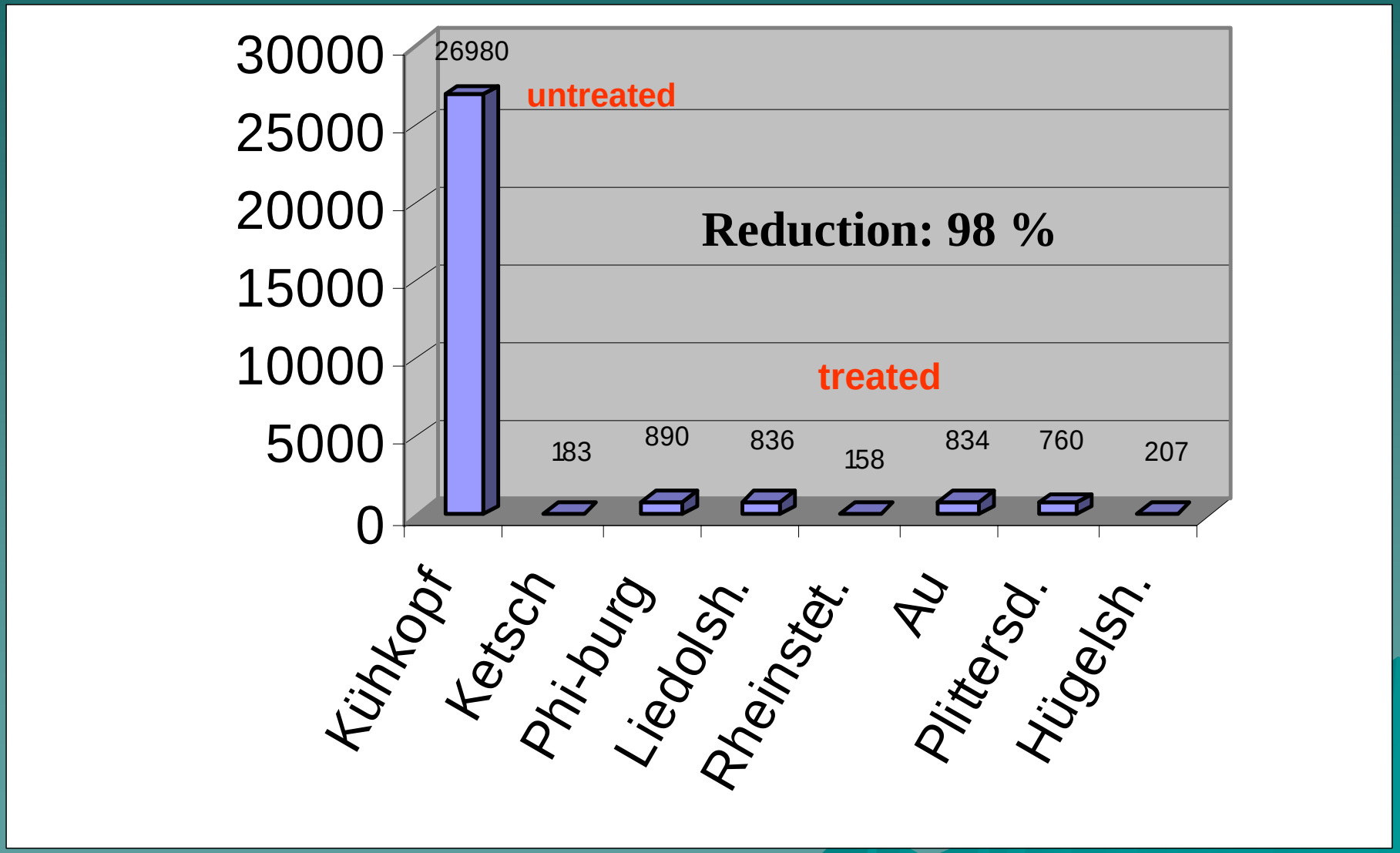
AERIAL APPLICATIONS WITH *B.t.i.* ARE PRECISE, SAFE AND EFFECTIVE



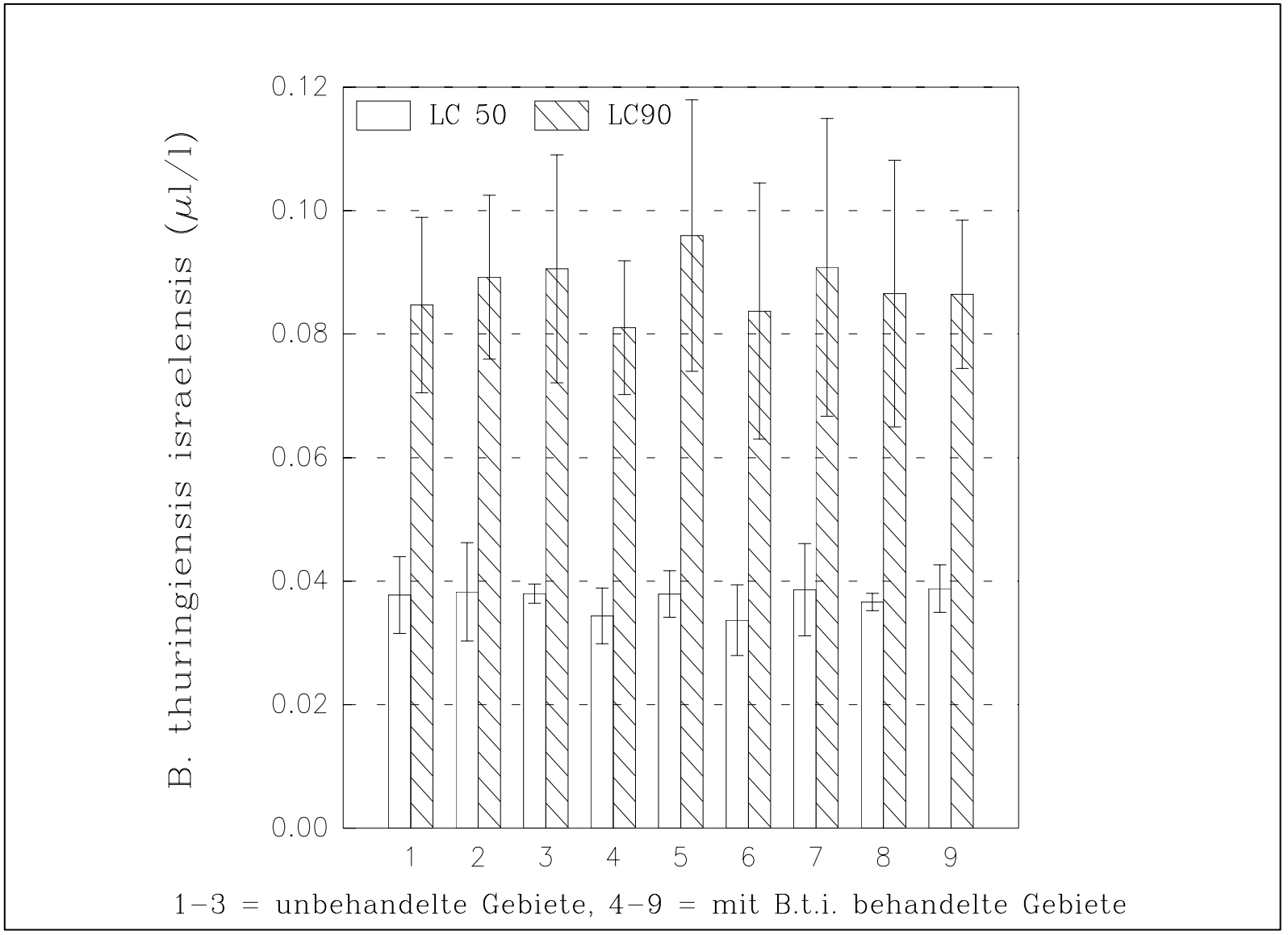


- **Precise application by using GPS**
- **Quick coverage of unaccessible areas;**
  - **To treat 1 hectare:**
    - **By helicopter in 1 minute;**
    - **Ground application 2 people for 1 hour**
- **With good calibration:**
    - **no overdosing,**
    - **no drift (although height can be up to 100 m**
- **No disturbance of wildlife (susceptible ecosystems e.g. orchids, birds).**

Reduction of Nuisance Mosquitoes



No Resistance after 25 years



Our goals are achieved; Results welcomed by the population

Without aerial application of Bti

Situation 1976

With aerial application of Bti

Situation 2008

VectoBac has been used over the past 25 years mostly by aerial application without significant adverse effects the environment and people

THANK YOU
for yor kind attention!