Halogenated Endocrine Disruptors in Wildlife:

Is there (still) a problem?

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Endocrine Disruptors in Wildlife
A recent problem ?

- Since the 60's polyhalogenated aromatic hydrocarbons (PHAHs　ハロゲン化芳香族炭化水素化合物) known endocrine disruptors reproduction and development
- Silent Spring by Rachel Carson
- Focus on combination biomagnification/ bioaccumulation and secondary poisoning
- Last decades much attention DDT, PCBs, dioxins etc.
- Stolen Future by Th. Colborn et al revived our chemophobia
（化学物質恐怖症）

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Major question:

Do current background levels of PHAHs in the industrialized world still present a threat to populations of top predators at the top of the aquatic foodchain?

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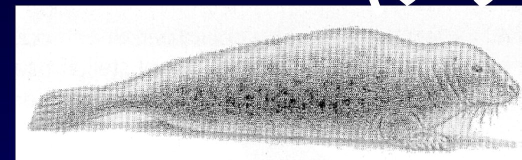
Wildlife and organohalogens in a global perspective

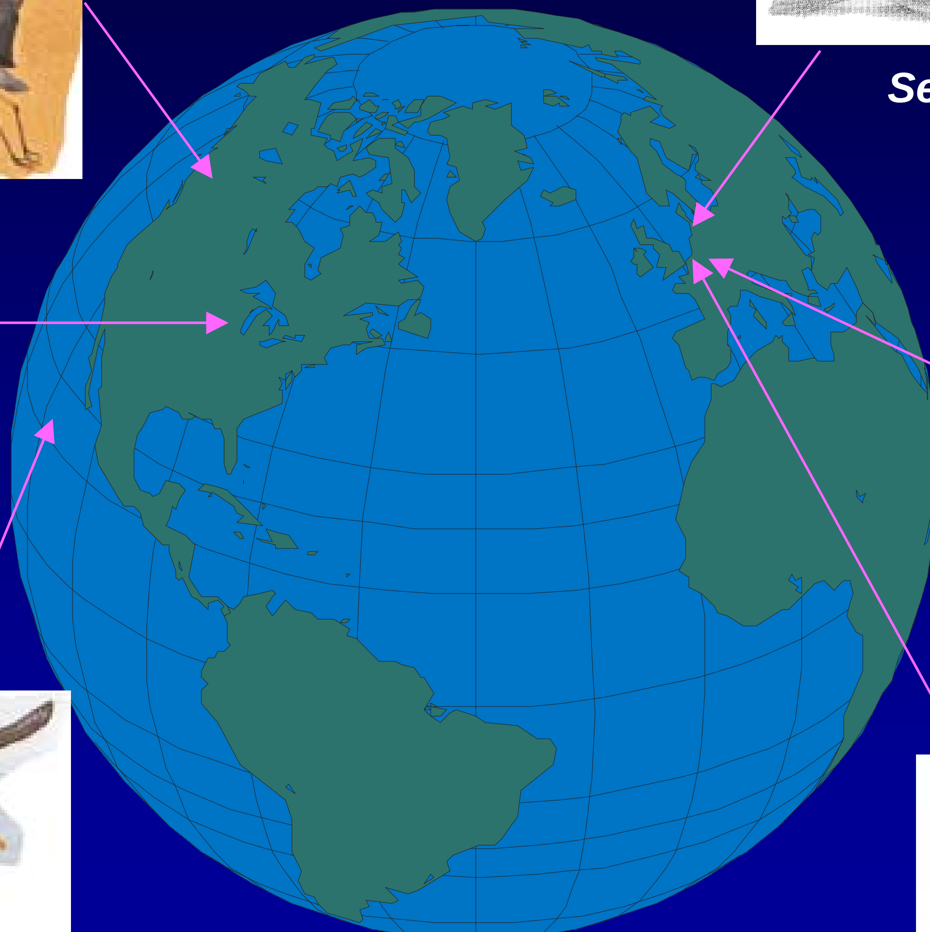
（有機ハロゲン）

(アオサギ)
Blue Herons
Canada

(アザラシ)



Seals in the Baltic
and North Sea



(ハクトウワシ)
Bald Eagles
Great Lakes

(カワウ)

Cormorants and
Common Terns
Rhine and Meuse
Estuaries

(アオサギ)
Albatrosses
Midway Island

(アジサシ)

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Organohalogens and Seals
(有機ハロゲンとアザラシ)

- *Baltic Seal Disease*
  - Field studies
  - OC Levels and trends
  - Reproductive succes
  - Extensive documentation:

  Bergman and Olson 1985,1994;Jensen and Jansson 1976;Haraguchi et al 1992;Helle et al 1976, 1980; Bergman et al 1994, 1999;Letcher et al 1999

- *Dutch Seal reproduction studies*
  - Two Semi-Field studies
  - Reproductive succes
  - Dose respons-relationships
  - Extensive documentation:

  Reijnders 1986,1999; Boon et al 1992;Brouwer et al 1989,1998;Murk et al 1994; De Swart et al 1994;Ross et al 1995.

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Seals and reproduction
（アザラシと繁殖）
in North-Western Europe

- Baltic Seal Disease
  - In the 70's/80's reproductive disorders and pathological lesions in uterus and adrenals.
  - Uterine lesions in 30% Gray Seal and 70 % Ringed Seal autopsies.
  - Symptoms firmly linked to high body burdens of PCBs, DDT and persistent $MeSO_2$-metabolites
  - With decreasing OC body burden *reproduction gradually **increased** during the last two decades*

（繁殖は徐々に増加）

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North Sea Seals: OCs, reproduction and morbillivirus
（モルビリウィルス）

- Seal Reproduction and Immunotoxicity studies

  （アザラシの繁殖と免疫毒性）

  - Two groups Harbor Seals fed open Atlantic (low OC) and North Sea/Baltic fish (high OC)
  - High OC group: effects on reproduction, thyroidhormones, vitamine A, steroidhormone levels, immunosuppression
  - PCBs, PCDDs and PCDFs most likely causal agents
  - *With decreasing OC levels observed **increase** in populations*

    （個体数の増加）

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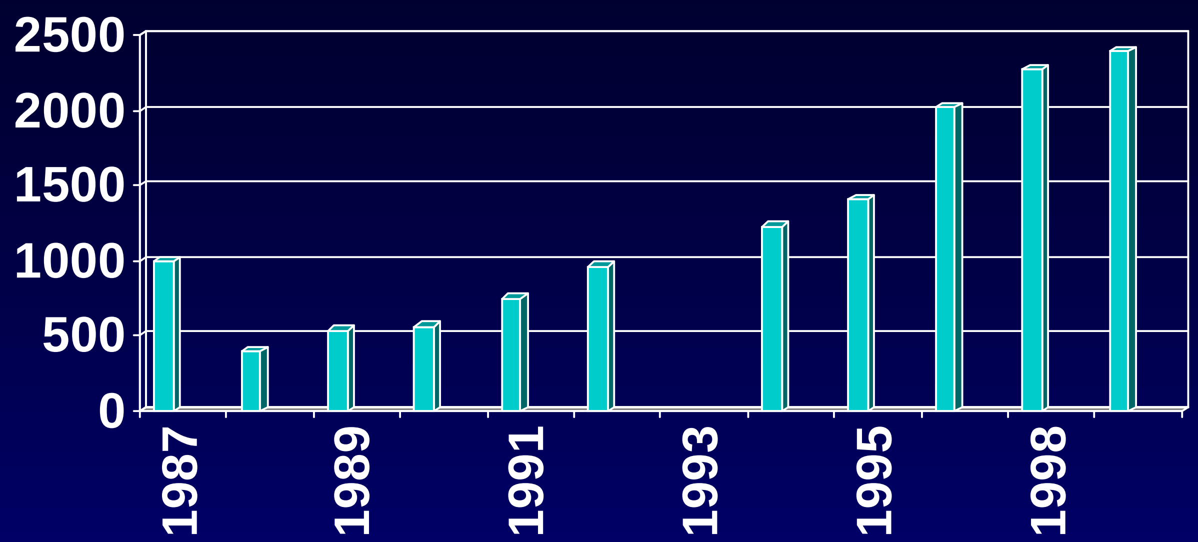

- Dutch Seals and morbillivirus

- Mass mortality in 1988
- A Morbillivirus - phocine distemper virus PDV-1 (Osterhaus and Vedder 1988)
- Immunosuppression: Natural Killer and T cells
- OCs confounding factor
- Rapid ***increase in population*** due to decrease OCs and natural selection ?

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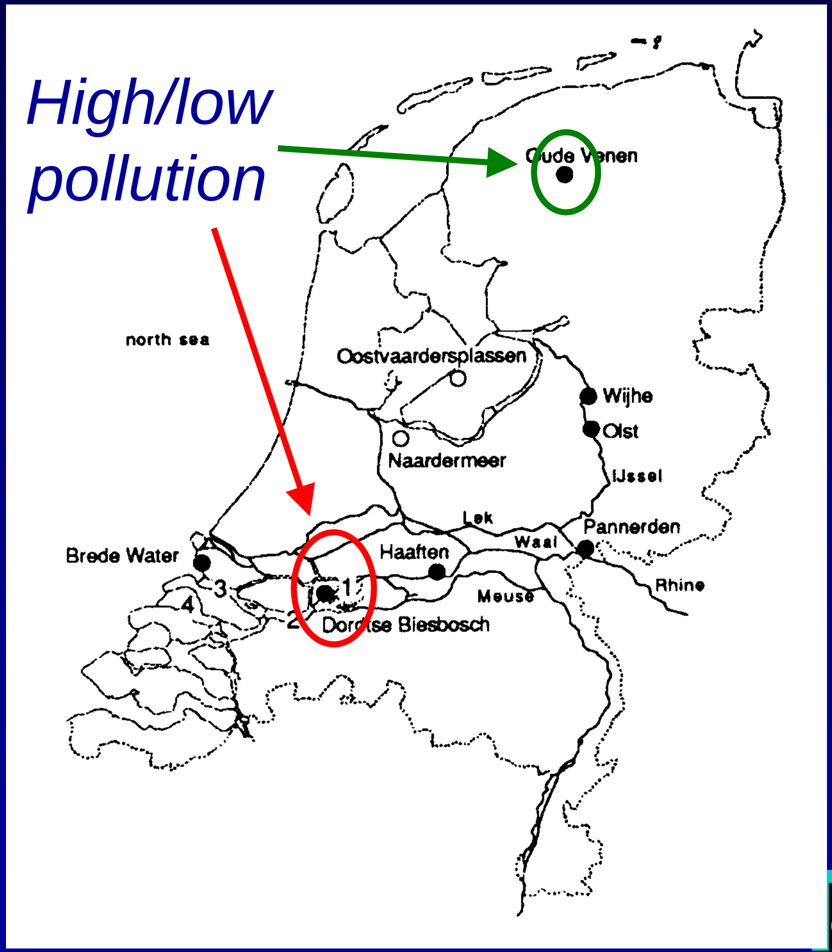
Cormorants in the Rhine and Meuse Estuaries

（カワウ）

(Dirksen et al., Env. Pollut.119,1995)



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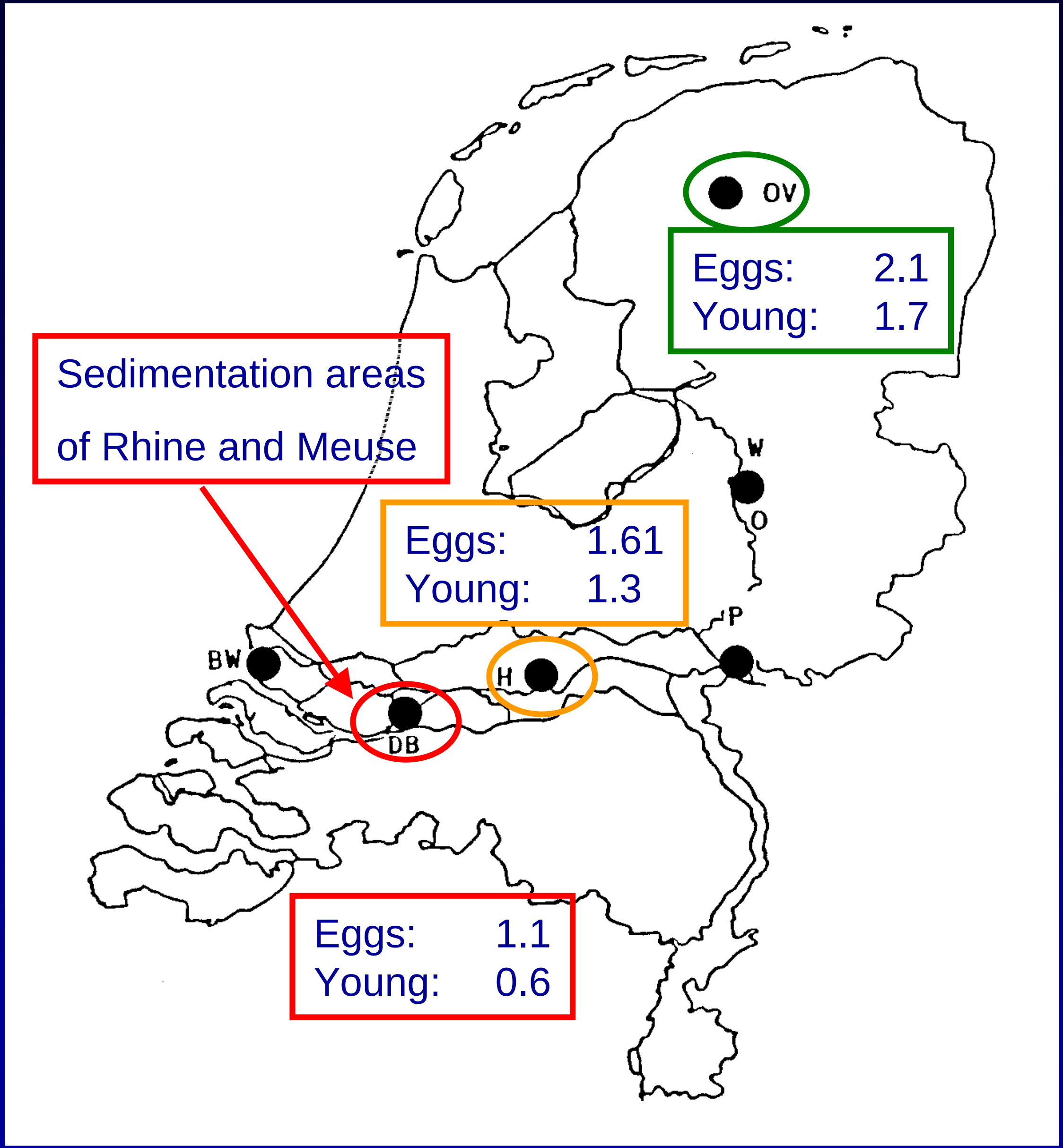
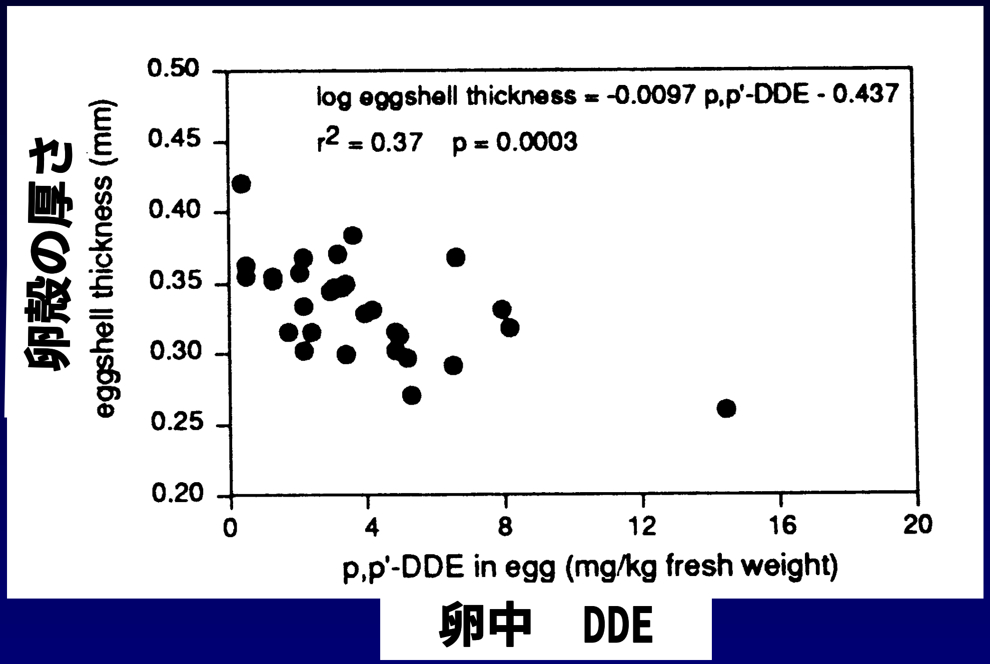
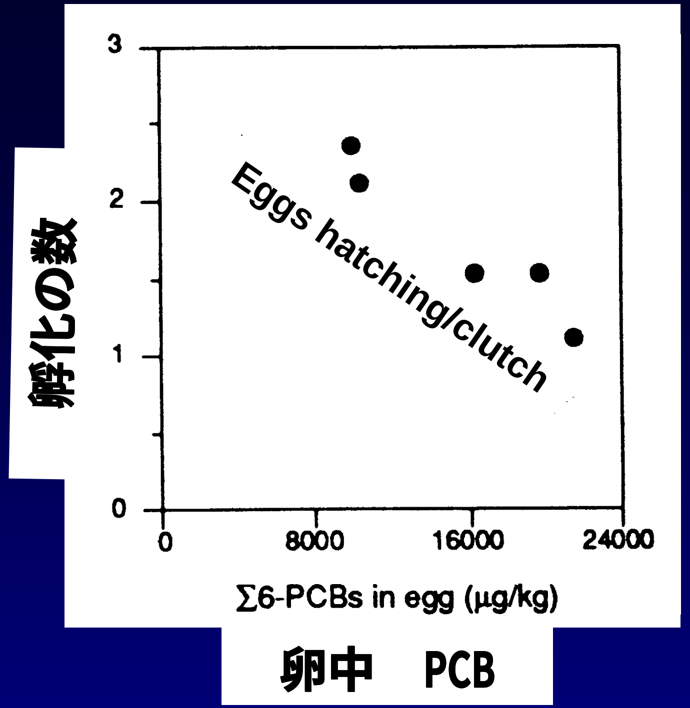
- ***Cormorant breeding data Netherlands:***
- Year 1988
- Fieldstudies 7 colonies
- Degree of pollution
  - Red = heavy
  - Yellow = intermediate
  - Green = low
- Eggs = hatchlings/clutch
- Young = fledgings/clutch







- Levels PCBs and DDE correlate with eggshell thickness（卵殻の厚さ） and hatching succes（孵化の成功率）
- 50 % less reproduction in sedimentation areas Rhine and Meuse
- At present *still effects expected* in sedimentation areas
- *Dutch and European population not threatened*

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Common Terns in the Rhine,Meuse and Schelde Estuaries
（アジサシ） *(The Netherlands and Belgium)*

(Bosveld et al., 1995 and 1999, Murk et al., 1994)

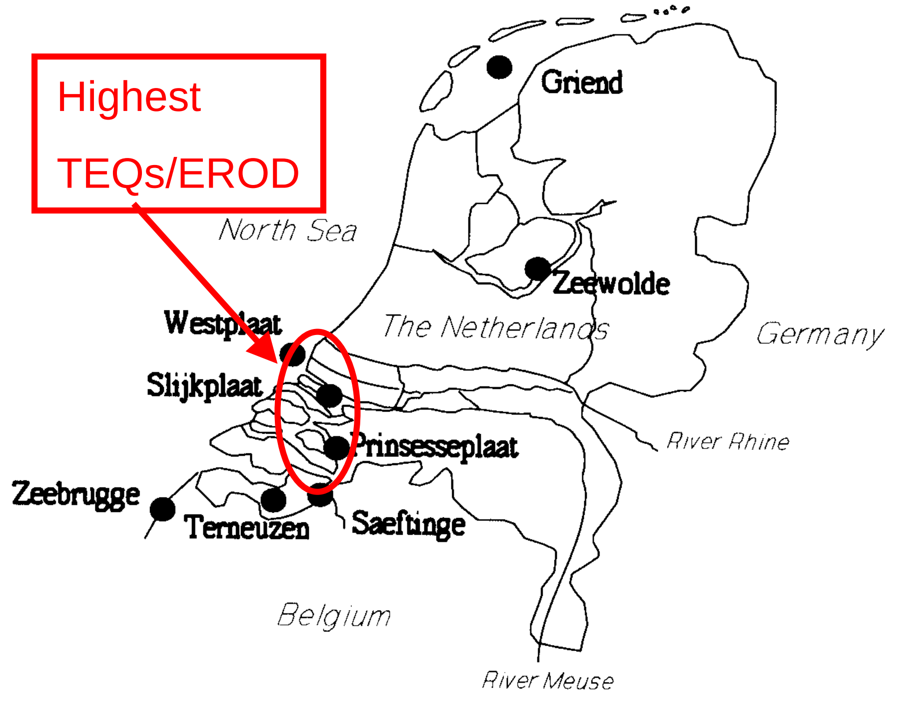

Fig. 1. Common tern egg sampling locations.

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- *Study 1:* In ovo exposure and effects on hatchlings（卵の時の曝露）
- *Study 2:* Postnatal exposure and effects on development chicks（出生後の曝露）
- *Wide range of parameters:* P450's, thyroidhormones, vitamin A, steroid hormone metabolism, general morphology and pathology

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CYP1A (EROD) induction & correlation with TEQs in Common Terns breeding in 8 Dutch and Belgium colonies
（アジサシ）

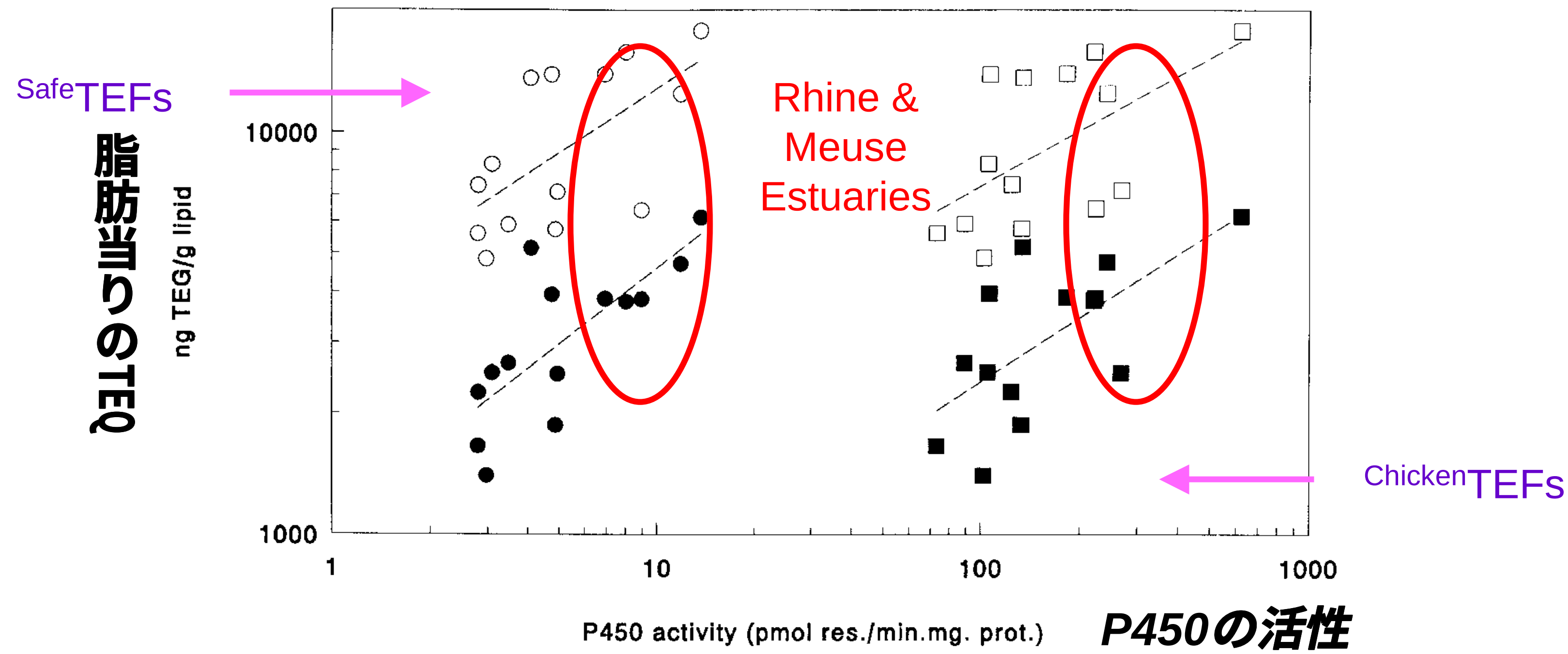

Fig. 6. Concentration effect relationships between log TEQ_{TOT} and log EROD and log PROD. TEQ_{TOT} calculation is based on PCDD, PCDF, non-ortho-PCB, and mono-ortho-PCB concentrations using the S-TEFs and the C-TEFs, respectively (see Table 3a). EROD vs. S-TEQ (□): $0.45x + 2.96$; $r = 0.568$, $p < 0.05$. EROD vs. C-TEQ (■): $0.52x + 2.52$; $r = 0.661$, $p < 0.02$. PROD vs. S-TEQ (○): $0.52x + 3.58$; $r = 0.631$, $p < 0.02$. PROD vs. C-TEQ (●): $0.63x + 3.03$; $r = 0.761$, $p < 0.01$.

TEQ: PCDD+PCDF+non-ortho PCB

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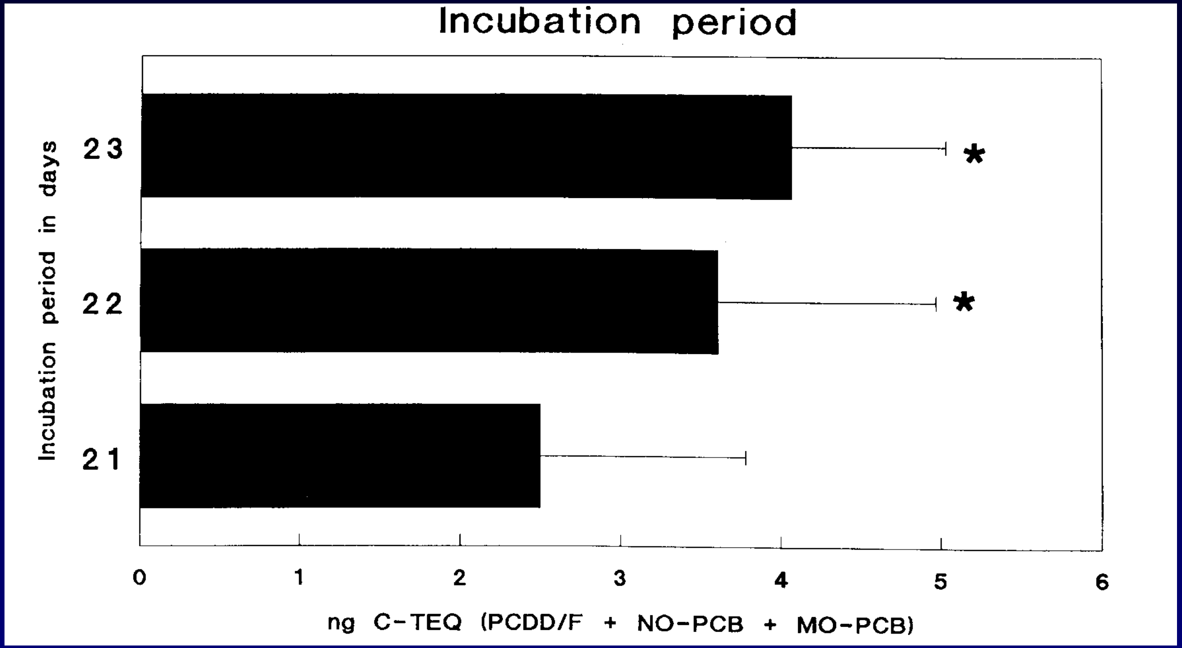
Semifield incubation study with hatchlings Common Tern （アジサシ）



- Approx. five fold more TEQs in yolksacs of hatchlings from Rhine and Meuse Estuaries
- In estuaries hatching period prolonged from 21 to 23 days and correlated TEQs and EROD
- No effects on morphology and physiology

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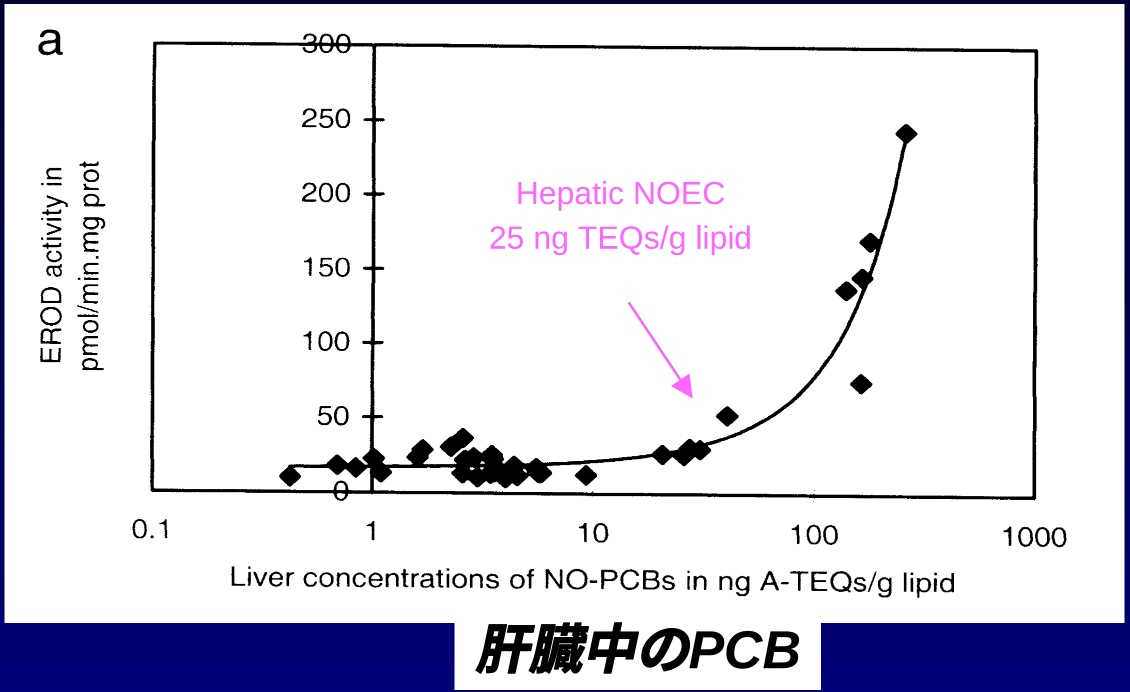
Feeding study hatchlings Common Tern with environmental relevant mixtures PCB 126 and PCB 153



- No significant effects on growth and morphology
- At 0.6 ng TEQs /g fish effects on CYP1A, and marginal on thyroxine levels and bursa weight
- Estimated no observed effect level CYP1A 25 ng TEQs/g liver lipid, which is equivalent with 0.6 ng TEQs/g fish ww
- Present Dutch fish levels approx. 0.1 ng TEQs/g ww

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Conclusions Common Tern and Cormorant

（アジサシ）　　　　（カワウ）

- Rhine and Meuse sedimentation areas among most highly polluted in the world
- Probably still effects on Cormorant
- No significant effects PHAHs on Common Tern
- Both species at present common in Europe and no indication of effects on general population

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Great Blue Herons in British Columbia

(アオサギ)

Sanderson et al. J. Tox.Env. Health 41,435 (1994)
Whitehead et al. Organohalogen Compounds 9,325 (1992)

- Field and laboratory studies
- Three colonies in Strait of Georgia near Vancouver
- One colony (Crofton) near pulp mill
- Crofton colony studied before (1988) and after (1991) remedial actions

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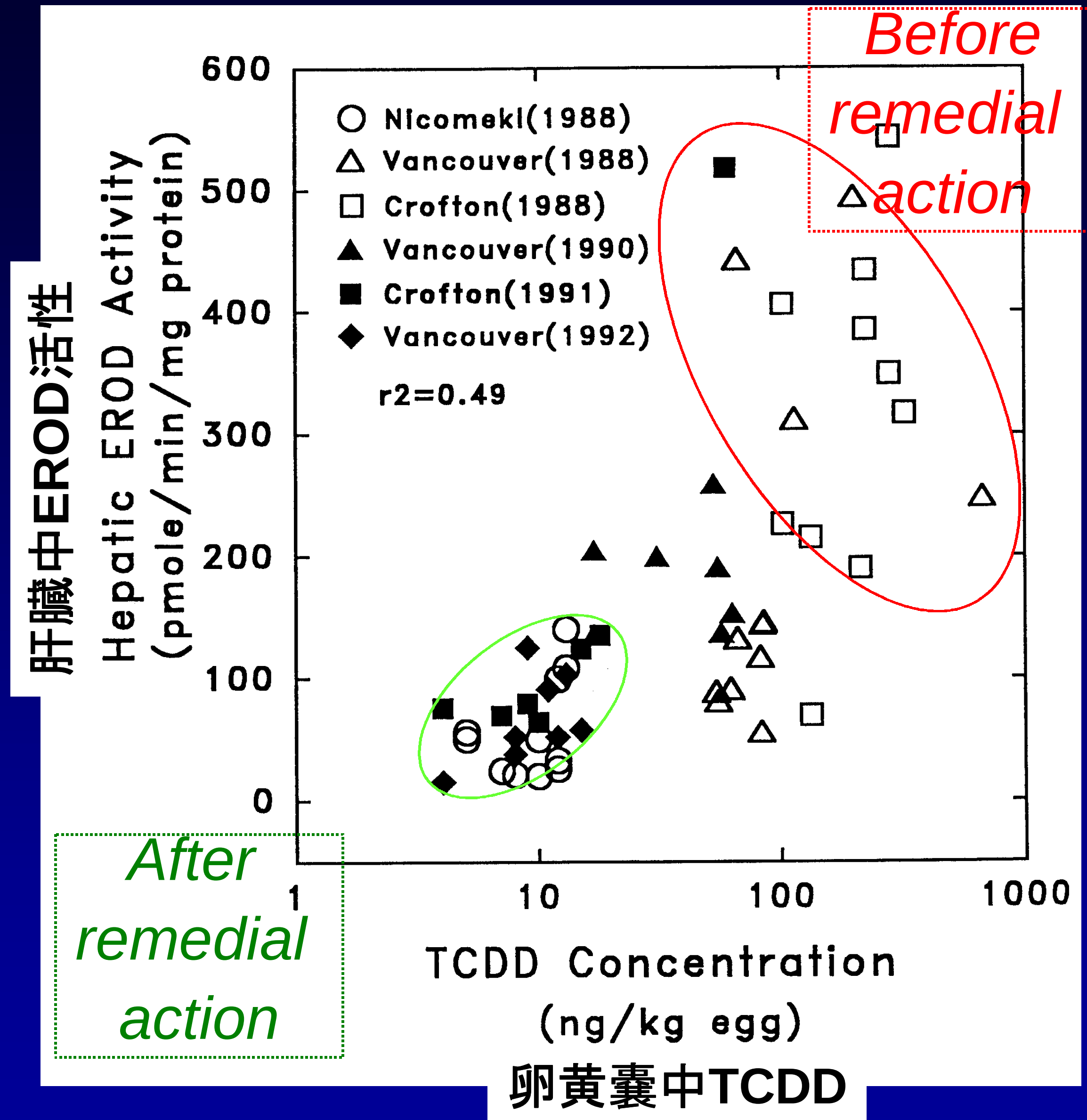
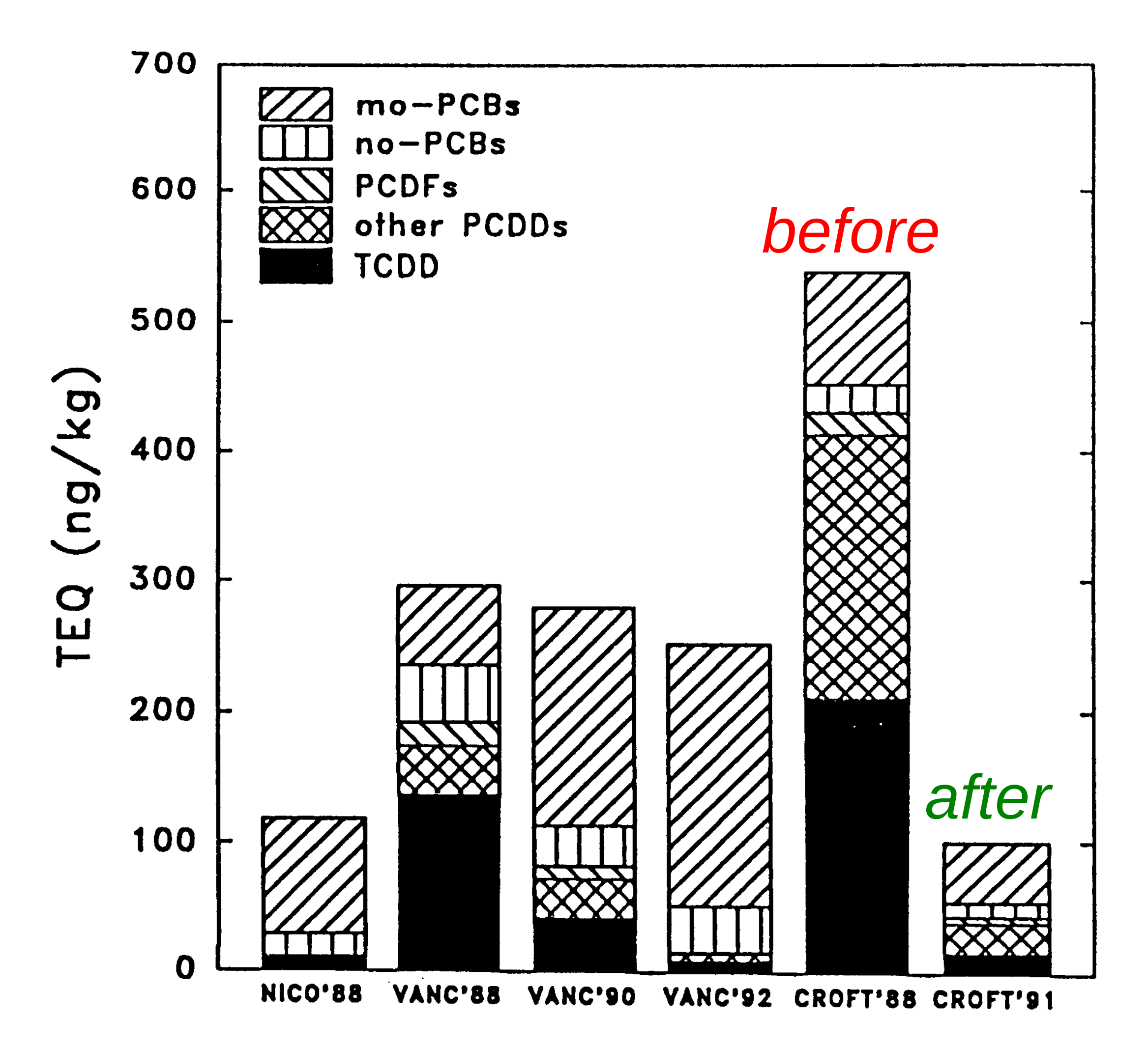
- Elevated EROD (CYP1A) activity with increasing TEQs
- Associated with morphological changes and chick edema



- After remedial actions (3 years) rapid improvement of reproductive succes
- Concurred with decrease in PCDD/F levels, EROD and morphological changes



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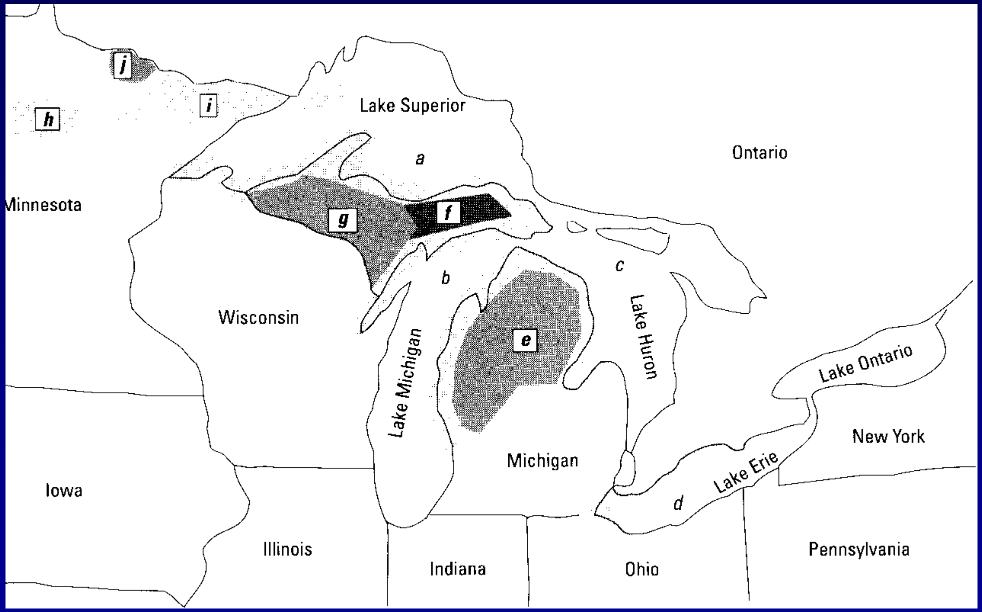
Reproduction of Bald Eagles in the Great Lakes
（ハクトウワシ）

J. Giesy et al. Env. Sci. Technol. 28, 128 (1994)

W. Bowerman et al. Env. Health Perspect. 103, 51(1995)



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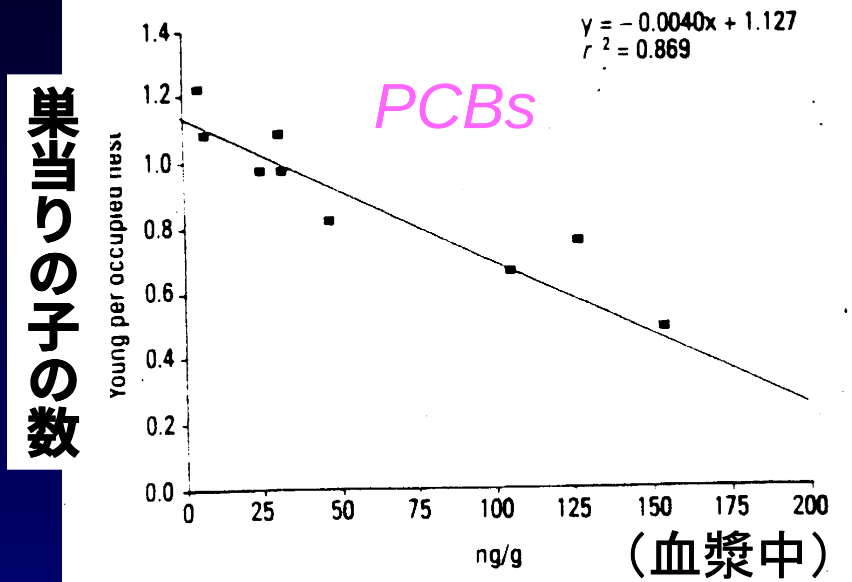

Figure 5. Relationship between overall productivity, 1977 to 1993, and geometric mean concentrations of total PCBs (ng/g, ww) in plasma of nine subpopulations of nestling bald eagles in the upper Midwest.

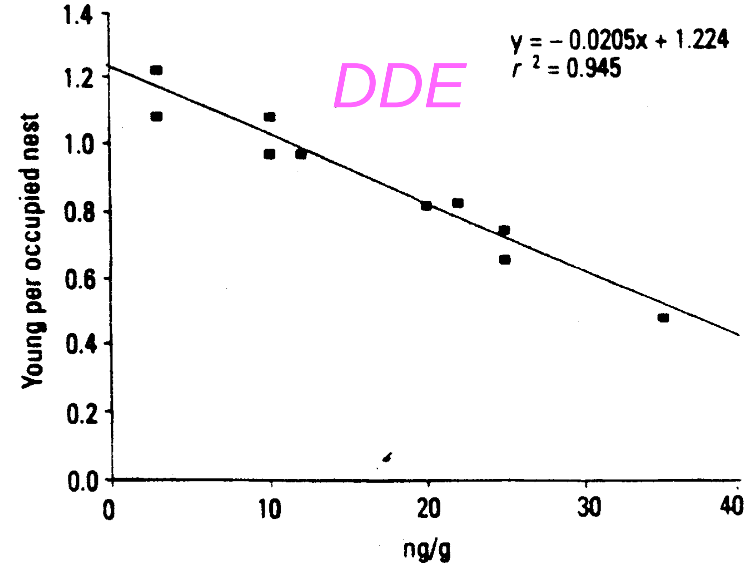

Figure 4. Relationship between overall productivity, 1977 to 1993, and geometric mean concentrations of *p,p'*-DDE (ng/g, ww) in plasma of 10 subpopulations of nestling bald eagles in the upper Midwest.

- Significant decrease DDE and PCBs concurs with increased reproductive succes
- For PCBs negative relationship stronger over the years
- In addition to effects DDE indications for role of PCBs

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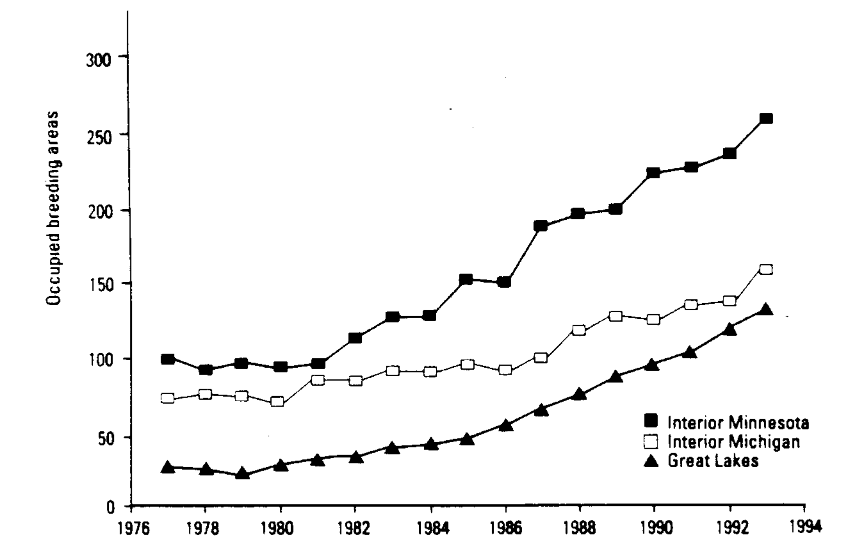

Figure 1. Numbers of occupied breeding areas of bald eagles nesting within the Great Lakes region for the period 1977 to 1993.

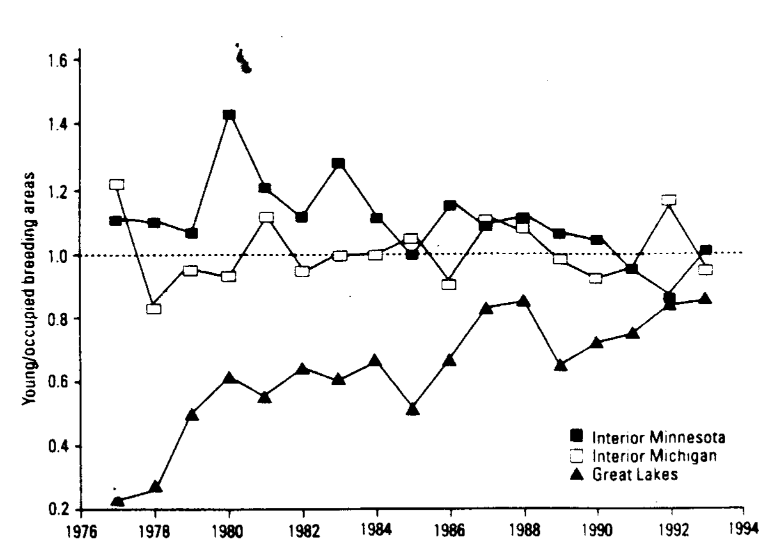

Figure 2. Productivity of bald eagles within the Great Lakes region for the period 1977 to 1993.

- Since 80's significant upward trend all Bald Eagle populations in the Mid West USA
- Reproductive success more contaminated areas in Great Lakes increased strongly in period 1976 - 2000, but still lower than in less contaminated inland areas in the 90's

Present situation Bald Eagle in Mid West USA

- Impact of DDE decreased
- Impact of PCBs (TEQs) still present in most contaminated sites Great Lakes and rivers open to spawning of salmonid
- Overall Bald Eagle populations no longer under threat by PHAHs

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Albatrosses（アホウドリ）in the Pacific: Midway Island a pristine environment ?

Albatrosses in the Pacific: Midway Island a pristine environment ?

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- Large colonies of Laysan and Black-footed Albatross
- Fluctuations of Pacific populations observed in the last decades
- Especially Black-footed Albatross has decreased since the 80’s

- Evaluation role organochlorines（有機ハロゲン）and fishery bycatch （漁業による副次的捕獲）on albatross populations (J.P. Ludwig et al., Albatross Biology and Conservation,p225 (1997)
- Combined project World Wildlife fund, US-EPA and US Fish and Wildlife Service
- Evaluation included population dynamics, PHAHs and information fishery bycatch

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Risk evaluation:

Organochlorines　（有機ハロゲン）:

- Blackfooted Albatross: 2-3% reduction in reproduction
- Laysan Albatros: probably no effect

Fishery bycatch（漁業に伴う副次的な捕獲）:

- Blackfooted Albatross: 27 % reduction in reproduction
- Laysan Albatros: 18 % reduction in reproduction

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- Fisher bycatch (long line fishing) accounts probably for 90 % observed decrease in reproduction, while organochlorines contribute not more than 10 %

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- Disposable cigarette lighters as contaminant and cause of death albatross chicks
- More common cause of death than chick deformities on Midway Island

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Organochlorines in Wildlife
Is there still a problem ?

- *No serious threat at present levels of background exposure to populations, even in the industrialized world*
- Supported by studies from various parts of the world showing recoveries of wildlife populations
- *Effects on reproduction can still be found in areas with high contamination (sedimentation)*
- These effects do not seem to have a serious impact anymore on populations as a whole

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Do we still have to worry about organohalogens ?

- ✔ PCBs?
  - More than 50 % still in closed systems
  - Proper and subsidized destruction
  - **<u>If not</u>** levels will not go down, but might go up!

- ✔ Other POPs
  - Use of cheap POPs in less industrialized and developing countries
  - Difficult choices e.g. DDT against Malaria
  - Richer countries might supply support for research and development of equally effective products to *<u>protect the global environment</u>*

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What about 'new' organohalogens ?

- ✔ Toxaphene ?
  - ☞ Persistent and bioaccumulation
  - ☞ Effects most pronounced at high levels
- ✔ Brominated diphenyl ethers ? （臭素化ジフェニルエーテル）
  - ☞ Persistent and bioaccumulation
  - ☞ Not highly toxic at low level exposure

Toxicity of these compounds for wildlife unlikely to be of the magnitude of dioxins, PCBs and DDE

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The Human – Wildlife Connection I

- ✓ Humans at the top of the foodchain
- ✓ Omnivorous and not exclusive carni- or piscivorous, but they are slow metabolizers
- ✓ Levels of PCBs and dioxins in the 90’s have led to measurable, but clinically not relevant, effects in breastfed infants, but their possible longterm impact is simply unknown
- ✓ Levels of dioxins are going down in humans and wildlife, while PCBs are levelling off in some industrialize countries after rigorous remedial actions.

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The Human – Wildlife Connection II

- Human exposure levels of PCBs and dioxins during the 60's, 70's and possibly 80's must have been one to two orders of magnitude higher than the present levels
- These high levels are now known to cause adverse effects in several animal species including primates, especially during the reproductive and developmental phase.

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The Human – Wildlife Connection III

- ***Suggestion*** within the wildlife – human connection could be to look for real adverse effects in the older human generations, that are now 20 to 40 years old and have been perinatally exposed to really high background levels of these compounds
- In retrospective conclusion, I think there are very little arguments to give that humans are an exception from wildlife, but at that time the subtle longterm but probably adverse effects of these compounds were unknown and scientists did not know what to look for.

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Other threats to wildlife?

- At present habitat destruction and intensive fish industry are a greater serious threat for wildlife populations than organohalogen compounds

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