Environmental consequences of the Chernobyl accident

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Ecological effects

S.T.A.L.K.E.R. Shadow of Chernobyl
Immediate effects:

- “Red” forest died & was cut down.
- Some cattle died (2nd generation normal)
Radiosensitivity of organisms

Ward Whicker et al.
Long term effects of chronic low doses

- From pre-Chernobyl and radiobiological studies, would not expect to see effects at doses less than 10 mGy/d (ca. 420 µGy/hr)

- Only very small areas at Chernobyl where dose rates are greater than this.
Moller and Mousseau
Moller and Mousseau’s Chernobyl Research Initiative


Barn Swallows at Chernobyl

Barn Swallow, *Hirundo rustica*. Photo by sannse, North Devon, 14 May 2004

![Graph showing nonbreeders (%) vs radiation (mR h⁻¹)]
Sampling site descriptions
Moller et al. 2005

“we studied barn swallows in parts of the southern and western sector just outside the exclusion zone of the Chernobyl area”

“we drove along all public roads to visit villages and collective farms in areas with high levels of radiation outside the exclusion zone near Chernobyl”

“While visits to areas with high levels of radiation is non-random, we see no reason why such a selection should be associated with farming practice, soil quality or abundance of insects, which are the main food for barn swallows”.

“One of our study sites (Vesniane) was within the exclusion zone, where farming ceased completely in 1986”
Barn Swallows at Chernobyl

![Graph showing nonbreeders vs. radiation at Bobor, Vesniane, and other Chernobyl sites.](image-url)
Effects on insects

- Dramatic population-level impacts of radiation on a range of organisms at Chernobyl at dose rates $< 10 \mu\text{Gy/hr}$

- More than 100 x lower than threshold for population-level impacts (10 mGy d$^{-1}$)

- Insects are believed to be more radio-resistant than most animal groups

Effect of radiation on the aquatic ecosystem
RESPOND
Radio-Ecological Study of the Chernobyl Cooling Pond and options for remediation

EU (INTAS); Royal Society

AQUASCOPE
Aquatic modelling study

AQUACURE
Countermeasures

Supported by
EU INCO - Copernicus
Other contaminants

- Limited study of heavy metals, organics in Cooling Pond and Glubokoye Lake.
  
  - No evidence of significant contamination from heavy metals (e.g. Boron, Lead) or organic contaminants (e.g. phenols).
Genetics and Fluctuating Asymmetry of Erythromma najas - Claire Cailes

Nymph → Adult Male
Fluctuating Asymmetry

Mean FA for Lakes

Mean FA + StDev

Svyatoye #7
Svyatskoye #5
Orange
Svyatoye #3
Glubokoye
Stoyecheye #8
Dvorsche
Persloki
## Abnormalities of fish

- **Severtsov Institute**

<table>
<thead>
<tr>
<th>Water Body</th>
<th>Time period</th>
<th>Internal dose</th>
<th>No. of fish studied</th>
<th>Abnormalities of body shape &amp; morphology of internal organs (%)</th>
<th>Asymmetry or abnormal shape of gonads (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling Pond</td>
<td>2002-2004</td>
<td>0.0062-0.079 mGy d⁻¹</td>
<td>197</td>
<td>0.5</td>
<td>5.1</td>
</tr>
<tr>
<td>Glubokoye</td>
<td>2003-2004</td>
<td>0.24-0.35 mGy d⁻¹</td>
<td>32</td>
<td>0</td>
<td>18.8</td>
</tr>
<tr>
<td>Kiev Res.</td>
<td>1999-2004</td>
<td>0.3-0.7 μGy d⁻¹</td>
<td>318</td>
<td>3.5</td>
<td>10.0</td>
</tr>
<tr>
<td>Teterev River</td>
<td>1999-2004</td>
<td>0.065-0.38 μGy d⁻¹</td>
<td>280</td>
<td>2.5</td>
<td>2.1</td>
</tr>
</tbody>
</table>
Biodiversity of the Aquatic Ecosystem

Number of fish species in contaminated lakes around Chernobyl

- No. of fish species
- No. of rare "Red Book" species

Increasing radioactive contamination ➔

Lakes:
- Smerdin
- Kiev Reservoir
- Zakrytoe
- Tyumenskoe
- Kozhanovskoe
- Syyatoe, Chechersk
- Petkovschina #12
- Syatsoe
- Kostiukovichy
- Perstok
- Glubokoe
- Cooling Pond
Biodiversity of insects in 9 lakes

- Lake area
- Lake depth
- Conductivity
- pH
- Total hardness
- Phosphate
- $^{137}$Cs load
Increasing dose rate →

Increasing dose rate →
Current effects:

- Some evidence of asymmetry indicating stress?
- Some evidence of increased genetic mutation rates
- No clear evidence of serious effects on overall health of organisms
Large mammal populations

Roe Deer; Dunin et al. (1998)

European Bison; Deryabina et al. (2006)
Ecological effects

- Dramatic decrease in animals associated with humans (pigeons, rats, sparrows)
- Dramatic increase in biodiversity and abundance of wild species

200 species of birds
55 species of mammals
8 species of reptiles
11 species of amphibians
55 species of fish

- Increase in game animals (moose, wild boar, roe deer, red deer, beaver, wolf)
Environmental cost-benefit

- Now a 3000 square kilometre Nature Reserve.
- Some effects of radiation on organisms.
- One could argue in purely environmental terms that Chernobyl has been a net benefit.
Conclusions

- Regulation of environmental impacts is a public relations exercise and will not benefit the environment.
- Need to continue empirical research at Chernobyl (and Fukushima) to test hypotheses about radiation effects on organisms.