integrated chemical and biological monitoring of the marine environment – the OSPAR approach

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Norwegian Institute for Water Research (NIVA)
acknowledgement

Norwegian JAMP: Norman Green, Anders Ruus

German monitoring programmes: Volkert Dethlefsen, Thomas Lang, Werner Wosniok

UK monitoring programmes: John Thain and co-workers

ICES/OSPAR WKIMON working groups: Ian Davies, John Thain, Colin Moffatt, Robin Law, Dick Vethaak, Thomas Lang, Kevin Thomas and other participants

ICES working group on biological effects of contaminants (WGBEC)
issues

- contaminants in marine ecosystems
- chemical analyses can not be used surrogates for effects
- limitations
  - environmental chemistry
  - biological effects
- integration?
  - a range of analyses in the same individual (JAMP, NO)
  - co-ordinated sampling (EFFSTAT, DE)
  - co-ordinated sampling, analyses and assessment (fullmonti, UK; WKIMON)
- quality assurance

find what you look for ..
bioavailability, etc
specificity
natural processes
OSPAR agreement

To take all possible steps to prevent and eliminate pollution and to take the necessary measures to protect the maritime area against adverse effects of human activities so as to safeguard human health and to conserve marine ecosystems and, when practicable, restore marine areas which have been adversely affected.
objectives

- spatial monitoring
- temporal monitoring
- novel substances
same individual

● general factors
  ● year, station
● physiology
  ● sex, maturation, length (size), condition, LSI, fat
● contaminants
  ● OH-pyrene (bile)
  ● OCs: HCB, PCB-153, mono-ortho PCBs, p.p’-DDE (liver)
  ● metals: Cd, Cu, Pb, Zn (liver); Hg (muscle)
● effects
  ● cytochrome P4501A activity (EROD)
  ● metallothionein, ALA-D

● multiple regression with effect as dependent factor
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adjusted $R^2 : 0.41$. $p < 0.001$
integrated assessment

- appropriate compartments and methods
- develop criteria for each parameter/endpoint
- weigh and combine results for methods
- simplify results to generate indicators (traffic light)
fullmonti

- UK monitoring data
- three components
  - chemistry
  - individual biological effects
  - benthic community
- traffic light indicators for UK coastal areas and estuaries
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ECOSYSTEM integration

WATER
- water chemistry
- water extract passive samplers (bioassays)
- hydrography
- bioassays
- other parameters

SEDIMENT
- sediment chemistry
- sediment characteristics
- sediment bioassays
- benthic ecology

BIOTA
- tissue chemistry
- fish biological effects
- mussel biological effects
- gastropod biological effects (inter-/imposex)

OSPAR WKIMON
tissue chemistry

whole organism response

Cd, Pb, Hg
Cu, Zn

scope for growth

Cd, Pb, Hg
Cu, Zn

condition index

PCBs

stress on stress

PAHs

growth

BFRs

histopathology

organotins

lysosomal stability

fluorinated compounds

micronucleus formation

AChE

MXR

Comet assay

metallothionein
FISH

tissue chemistry
  Cd, Hg, Pb
  Cu, Zn
  organochlorines
  BFRs
  fluorinated compounds

whole organism response
  condition index, LSI, GSI
  reproductive success

subcellular response
  liver histopathology
  liver microscopic neoplasms
  external fish disease
  intersex

PAH metabolites
  EROD/CYP1A
  vitellogenin
  lysosomal stability
  DNA adducts
  AChE
  Comet assay
  metallothionein
  ALA-D
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conclusions

- assessment of environmental impacts of contaminants require both chemical analyses and biological effects
- co-ordinated analyses in same individual will not provide all required information
- temporal and spatial co-ordination is essential, but not sufficient
- an integrated programme requires water, sediment and biota components
- assessment frameworks need to be transparent and include relevant ecosystem components
- lack of correspondence between effects and contaminant concentrations may indicate the presence of unknowns
- quality assurance is critical
challenges

- integrated assessment framework
- assess contaminant impacts in relation to other environmental stressors (fisheries, eutrophication, habitat change, etc)
- national compliance, competence and resources
- quality assurance