Protection of the environment in existing exposure situations

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Outline

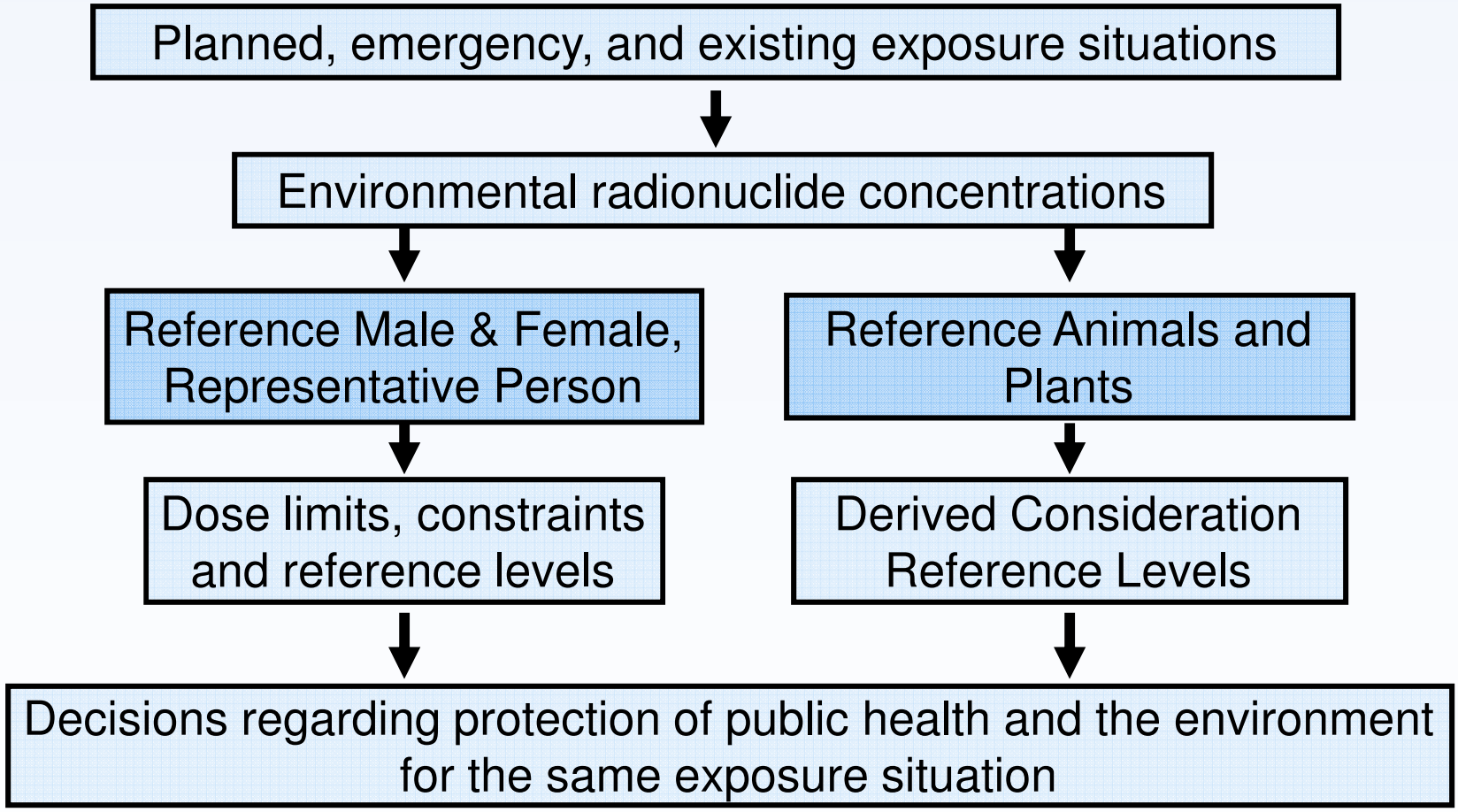
- DCRLs & their application in existing exposure situations
- Case studies
- Considerations for existing exposure situations with respect to the environment
- Lessons learnt
- Next steps

This presentation has neither been approved nor endorsed by the Main Commission of ICRP

Existing exposure situations

- …"*resulting from sources that already exist when a decision to control them is taken*" – ICRP, 2007
- International Basic Safety Standards adds
- …"*existing exposure situations include situations of exposure to natural background radiation*"
- …"*were not subject to regulatory control or that remains after an emergency situation*"
- Decision of when to move from *emergency* to *existing* – is a pragmatic, situation-specific decision

Parallel pathways



[*Publication 108*]

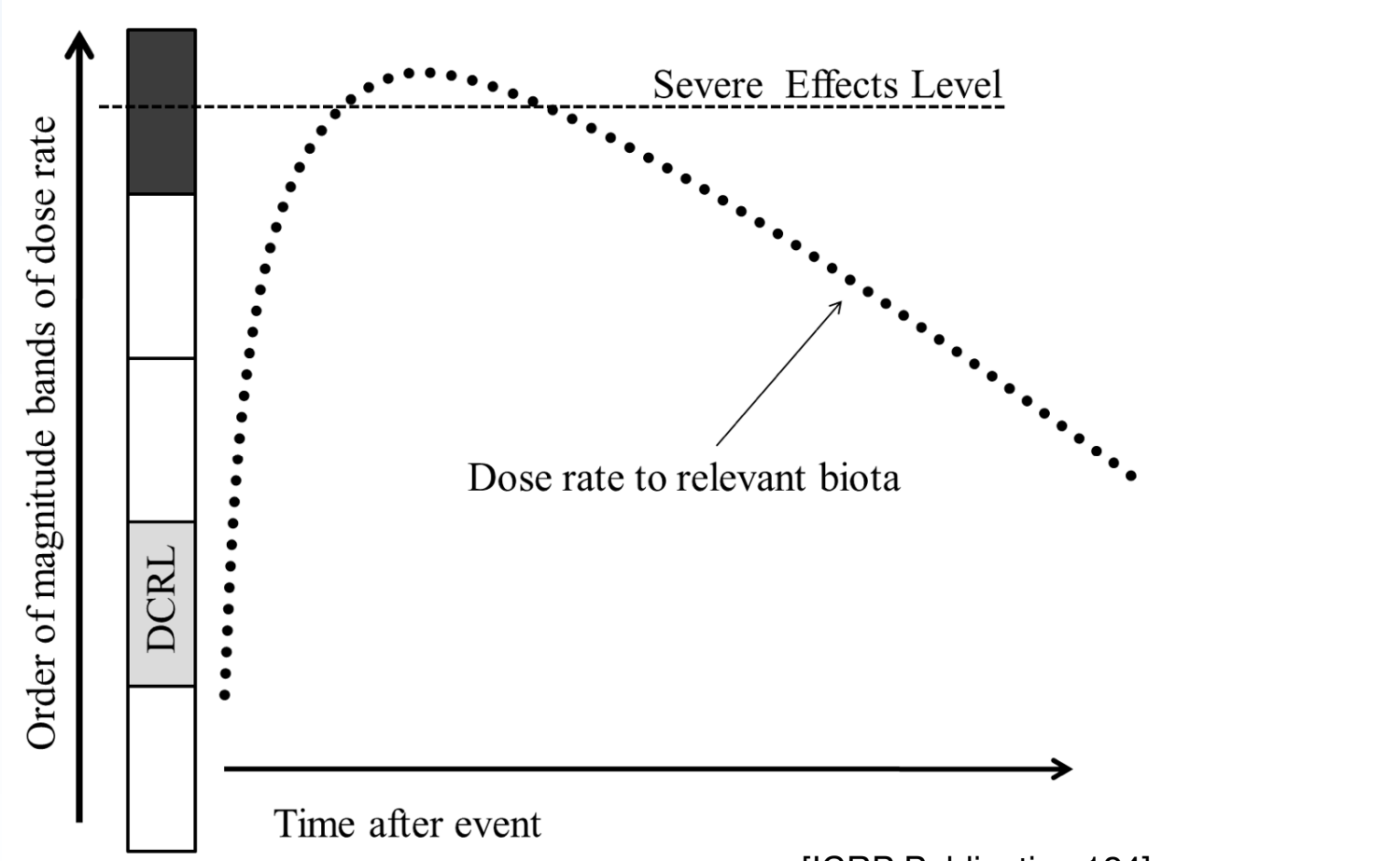
Derived Consideration Reference Levels (DCRLs)

- ICRP Publication 108:

- *"A DCRL can therefore be considered as a band of dose rate within which there is likely to be some chance of deleterious effects of ionising radiation occurring to individuals of that type of Reference Animal or Plant, derived from a knowledge of defined expected biological effects for that type of organism that, when considered together with other relevant information, can be used as a point of reference to optimise the level of effort expended on environmental protection, dependent upon the overall management objectives and the exposure situation."*

Application

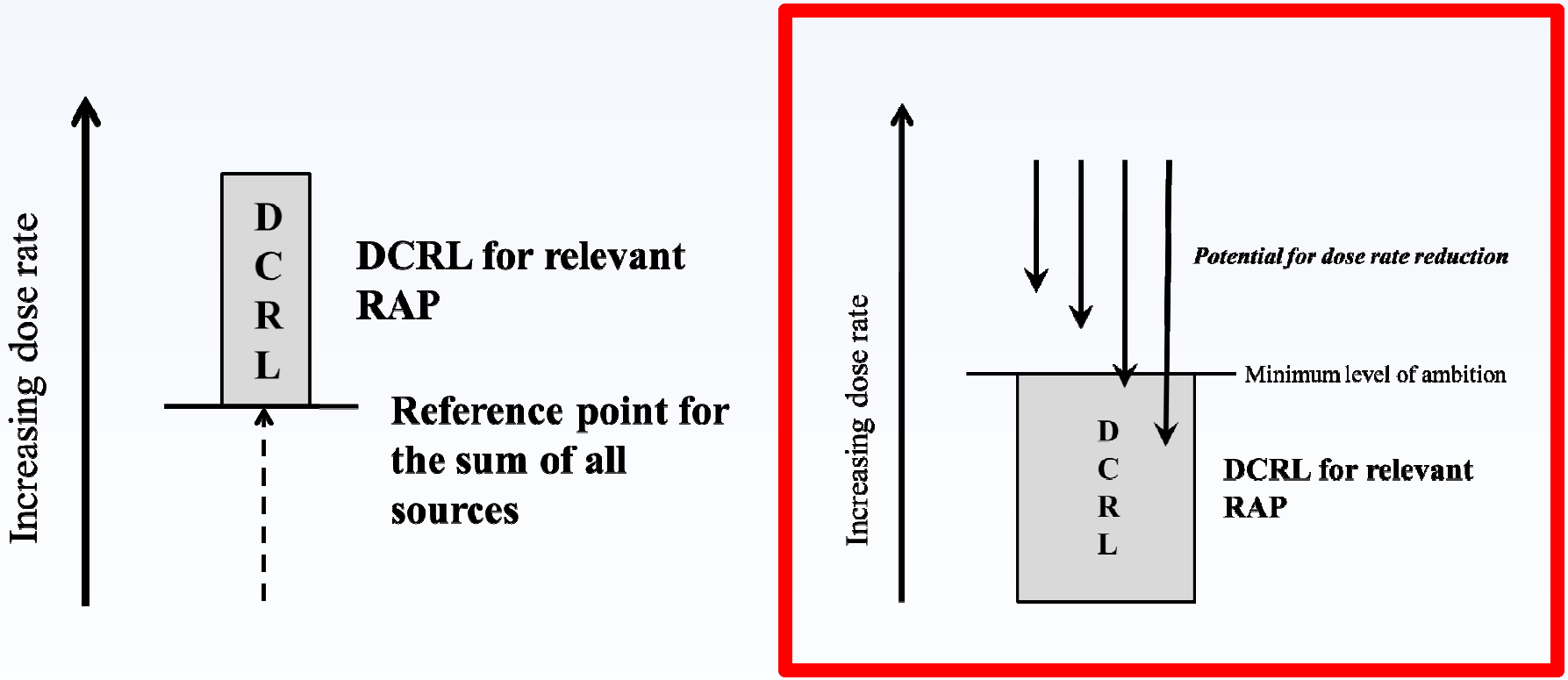
Emergency exposure situations



[ICRP Publication 124]

Application

Planned and existing exposure situations



[ICRP Publication 124]

DCRLS in existing exposure situations

- **ICRP Publication 124:**

- "**…***the Commission recommends that the aim should be to reduce exposures to levels that are within the DCRL bands (or even below, depending upon the potential cost/benefits) but with full consideration of the radiological and non-radiological consequences of doing so***.**"

RAPs and DCRLs

Wildlife group	Ecosystem[1]	RAP	DCRL, mGy d^{-1} (shaded)		
			0.1-1	1-10	10-100
Large terrestrial mammals	T	Deer			
Small terrestrial mammals	T	Rat			
Aquatic birds	F, M	Duck			
Large terrestrial plants	T	Pine tree			
Amphibians	F, T	Frog			
Pelagic fish	F, M	Trout			
Benthic fish	F, M	Flatfish			
Small terrestrial plant	T	Grass			
Seaweeds	M	Brown seaweed			
Terrestrial insects	T	Bee			
Crustacean	F, M	Crab			
Terrestrial annelids	T	Earthworm			

[1]T, terrestrial; F, freshwater; M, marine

Dose rate (mGy d^{-1})	Reference Pine tree	Reference Wild grass	Reference Brown seaweed
>1000	Mortality [5 to 16 Gy LD_{50}].	Mortality [16 to 22 Gy LD_{50}].	Deleterious effects expected at very high dose rates. No LD_{50} data.
100 - 1000	Mortality of e trees after prolonged ex ure.	Reduced oductive capacity.	Effects on growth rate.
10 - 100	Mortality of e trees after very long ex re. Growth defe Reduced rep ctive success.	Reduced oductive capacity.	Potenti ects on growth and reprodu success.
1 - 10	Morbidity ssed through anato ical and morphological damage. Prolonged exposure leads to reduced reproductive success.	No infor n.	Potenti ects on growth
0.1 - 1	No information.	No information.	No infor ion.
0.01 - 0.1	No information.	No information.	No information.
< 0.01	Natural background.	Natural background.	Natural background.

(Some) features to consider for existing exposure situations

- What are the key properties for the radionuclide in terms of its chemical and physical characteristics
- Area of contamination
- Location/position (e.g. depth) of contamination
- Number of people affected and their activities
- Wildlife presence and population affected
- Public opinion, legal situation, political constraints etc.

- Etc.

Case Study 1: Andreeva Bay

- Radioactive waste storage site remediation in Northwest Russia
- Cs-137 and Sr-90
- Investigation of radiation exposure on wildlife and humans
- Locally relevant species:
  - Motley grass
  - Squat birch
  - Earthworm
  - Moor frog
  - Norwegian lemming

Case Study 1: Andreeva Bay

Remediation Option	Site	Representative organisms	Dose rate maxima, mGy d^{-1}	DCRL, mGy d^{-1}
Conversion	STS Industrial Area	Moor frog	67.2	10-100
		Motley grass	**14.6**	1-10
		Lemming	**148.9**	0.1-10
		Earth worm	0.6	10-100
		Birch	**43.9**	1-10
	STS Supervision Area	Moor frog	0.4	1-10
		Motley grass	0.1	1-10
		Lemming	1.0	0,1-1
		Earth worm	0.1	10-100
		Birch	0.3	1-10
Conservation	STS Industrial Area	Moor frog	38.1	10-100
		Motley grass	8.3	1-10
		Lemming	**84.4**	0.1-1
		Earth worm	0.4	10-100
		Birch	**24.9**	1-10

Case Study 1: Andreeva Bay

- Key findings:
  - All human assessments are within given criteria
  - Individuals of the wildlife species of interest may receive dose rates in excess of the DCRL
  - On site population affected is small relative to wider area
  - On site population affected most by building and construction work

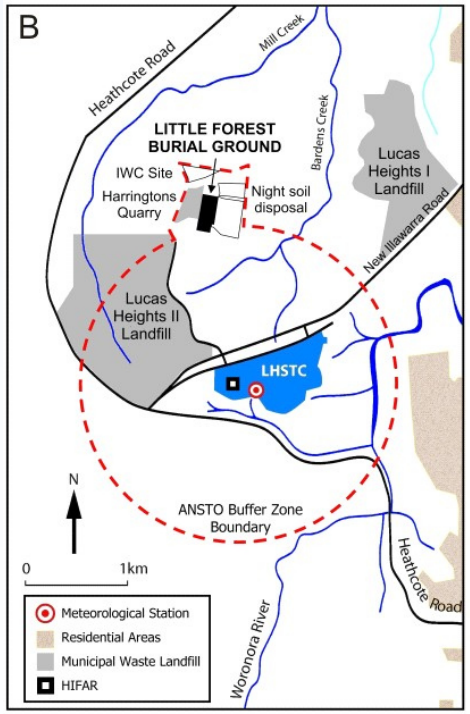
- Remaining questions:
  - Observable effects?
  - Trans-generational?
  - Affected population size?

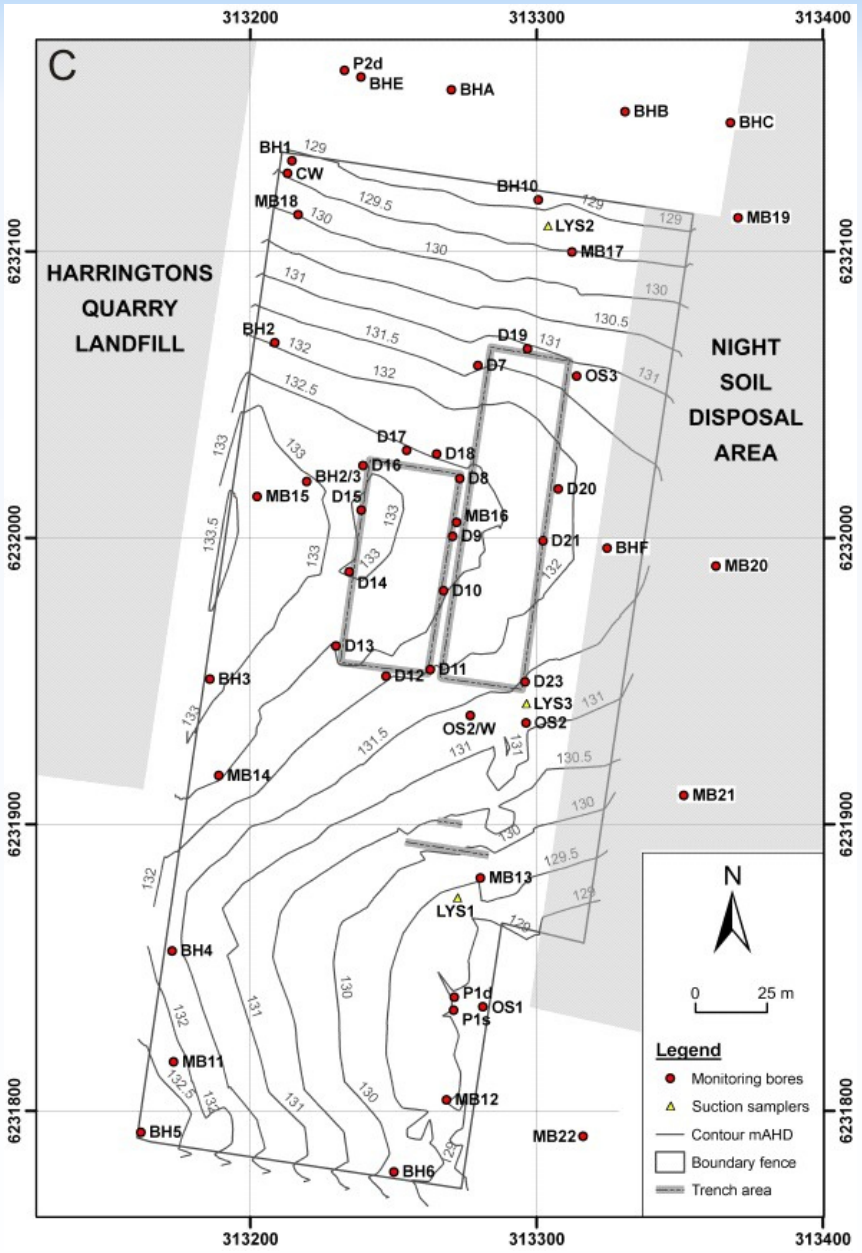
Case Study 2: Mayak

- Historic radioactive releases of wastes into Techa River (e.g Cs-137, Sr-90)
- Fish species, sediments, waters, zooplankton, algae and zoobenthos studied (2011-13)
- Fish – changes in weight, age, sex, fin colour, reproductive endpoints & cytological investigations
- Dose estimated as 220 microGy/day (below relevant DCRL)
- Levels of radionuclides did not exceed human dose limits or constraints
- Complex with ongoing planned and existing exposure situations

Case Study 3: Little Forest Legacy Site

- New South Wales, Australia





- Dose assessments to Acacia trees and Amphibian (frog) are around DCRLs

Case Study 3: Little Forest Legacy Site

- Findings
  - All human exposure scenarios below 1 mSv a^{-1} threrefore no reference values required
  - Wildlife considered with most being below relevant DCRL
  - But… frog and tree assessments highlighted potential to exceed the relevant DCRL
  - Direct comparisons of human and wildlife not possible but maybe wildlife need to be considered specifically
  - Spatial extent may need to be considered

Lessons learnt

- Need to examine on a case by case basis
- Derived CONSIDERATION Reference Levels may be used to help understand the likely consequences on wildlife
- Environmental protection may need to be considered as part of the management/decision making process for existing exposure situations

Lessons learnt

- Key is to understand what the consequences of management actions are likely to be on environment noting:
  - Any actions to improve radiological situation will likely have similar impact on wildlife
  - BUT physical impact on biota?
  - So need to know population affected? Size, timescale, area etc.
- Decisions are value-laden varying on a case by case basis and dependent to a degree on local stakeholders
- Examples highlight that we may need to consider wildlife as a component of strategies for long-term management of existing exposure situations

Conclusions

- **General principle**
  - By considering radiological and non-radiological impacts on wildlife aim to do more good that harm in any management approach adopted

- **Justification** of any changes anticipated following management action in terms of both humans and wildlife

- We may need to produce **additional guidance** and **recommendations** incorporating environmental radiological protection e.g.
  - What to do if the assessment indicates impacts above the DCRL for wildlife but where there is no significant human impact
  - What to do in complex situations with both existing and planned exposure situations

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