

## **RADIONUCLIDE ANALYSIS OF SAMPLES OBTAINED FROM AMCHITKA AND KISKA (REFERENCE SITE)**

Multiple replicate samples of marine biota species representing several trophic levels are being collected from the off-shore vicinity of the Amchitka test shots and Kiska (as a reference site). Initially, one composite sample (reflecting multiple individual organisms of the same species from the same general location) from each Amchitka and Kiska sampling location will be analyzed for specific radionuclide isotopes as a screening survey. This screening survey will be limited to a maximum of 25 species for analysis. The results of this screening survey will then be used to select one species from each trophic level for more extensive analysis of multiple composite samples. More than one species may be selected from a single trophic level for species that serve as primary food sources. Considerations in the selection of the species for more extensive analysis will include identification of the species that is estimated to present the greatest human health risk (considering measured radionuclide levels, isotope-specific risk factors and consumption rates) and the ability to measure isotopes indicative of the source of the radionuclides present. Although a greater number of biological samples are being obtained during the field expedition, the current program is limited in total to the analysis of approximately 600 samples for  $^{137}\text{Cs}$ ,  $^{152}\text{Eu}$ ,  $^{60}\text{Co}$  (gamma emitters) and 200 samples for other isotopes. Samples not analyzed are being retained for future analysis if such analysis is warranted based on findings under the current program and sufficient resources are available. Detailed logic for the selection of specific species for analysis is included in the Appendix.

A limited number of sediment and water samples also are being collected i) where anomalies in marine salinity suggest the possibility of groundwater discharge from below Amchitka, and ii) where biological sampling occurs. Selected water samples (up to 20) will be analyzed for tritium. Selected sediment samples (up to 20) will be analyzed for the suite of gamma, alpha and beta emitters indicated below.

Isotopes of interest for analysis in this study are  $^{137}\text{Cs}$ ,  $^{152}\text{Eu}$ ,  $^{60}\text{Co}$  (gamma emitters),  $^{238, 239, 240, 241}\text{Pu}$ ,  $^{234, 235, 236, 238}\text{U}$ ,  $^{241}\text{Am}$  (alpha emitters), and  $^{90}\text{Sr}$ ,  $^3\text{H}$ ,  $^{99}\text{Tc}$ ,  $^{129}\text{I}$  (beta emitters).  $^{137}\text{Cs}$  and  $^{90}\text{Sr}$  are considered the isotopes most likely to accumulate in muscle (soft tissue) and cause human health risks through consumption. Other isotopes accumulate preferentially in either skeletal material (bones or exoskeletons) or specific organs, with a lesser distribution in muscle. Thus, for programmatic efficiency, analysis for specific isotopes will focus on sample types (soft tissue or skeletal material) most likely to contain the greatest amounts of the specific isotopes and to cause human health risk. Detection limits for analyses will be below levels necessary to detect human health risks based on conservative estimates of lifetime consumption and risk thresholds. More limited analysis will be used to ascertain the distribution of specific isotopes amongst the sample types for a given biota. Ratios of isotopes of Pu (indicative of nuclear detonations) and U (indicative of nuclear reactor releases and enrichment processes) will be used to the extent possible to identify whether Amchitka test shots are the likely source of measured radionuclides in samples. Analysis procedures appropriate for each isotope in each specific analytical matrix will be validated prior to actual sample analysis.

Quality control procedures include the use of blanks, blind spiked samples as positive controls, and approximately 20% of the analyses carried out by a separate laboratory than the primary analytical laboratory for comparison purposes. All samples will be handled under rigorous chain of custody. Idaho National Engineering and Environmental Laboratory (INEEL) will be the primary analytical laboratory for alpha and beta emitting isotopes. Vanderbilt University will be the primary analytical laboratory for gamma emitting isotopes.

## Appendix – Logic Summary for Prioritization of Biota Samples for Analysis

1. Underlying assumptions
  - a.  $^{137}\text{Cs}$  and  $^{90}\text{Sr}$  accumulate to a significant extent in the soft tissue (muscle) that is typically consumed.
  - b. Other isotopes that are expected to result from the test shots accumulate primarily in skeletal material.
  - c. Isotope ratios of U and Pu, which provide information on the potential source of the isotopes, preferentially accumulate in the skeletal material.
  - d. **Therefore**, analysis of soft tissue provides the primary insight into human health risks from consumption, while analysis of skeletal material provides primary insights into the potential sources of the radionuclides and foodchain transfer. Analysis of soft tissue is to provide insights into potential human health risk and provide a baseline for comparison with potential future studies. Analysis of soft tissue also will provide insights into food chain transfer in the marine ecosystem. Analysis of skeletal materials is to provide indicators of sources of contaminants, information about foodchain accumulation, and to provide a baseline for comparison with potential future studies.
  - e. Information of ambient or reference levels for the isotopes of interest in marine species is limited, especially for isotopes other than  $^{137}\text{Cs}$ .
  - f. Information on thresholds for individual isotopes that result in ecological risk for the specific marine species of interest is very limited. CRESP continues to review the status of such data.
  - g. **Therefore**, analysis of species that are not primary contributors to human consumption is primarily to obtain a baseline for comparison with potential future studies.
  - h. Initial screening of marine biota using gross alpha and beta analysis has been determined not to be used because of the tradeoffs between cost, sensitivity, specificity and sample requirements. Instead, isotope specific screening as identified under (3) below will be used.

2. Priority in addressing specific programmatic objectives are as follows:
  - a. Defining the human health risk posed by the primary consumed components of subsistence and commercially consumed marine biota. Minor diet components are not as important as primary diet components.
  - b. Identifying the potential sources of radionuclides that are identified to cause significant human health risk.
  - c. Establishing the baseline of radionuclide concentrations in the primary consumed components of subsistence and commercially consumed marine biota.
  - d. Identifying the potential sources of radionuclides that are above detection limits while establishing the baseline in the primary consumed components of subsistence and commercially consumed marine biota.
  - e. Analysis of marine samples that are the lowest trophic levels (e.g., kelp and sediments) that potentially may accumulate radionuclides.
  - f. Analysis of marine biota from different trophic levels that would be indicative transmission and accumulation of radionuclides through the ecosystem.
3. Screening analysis will be performed on one composite for each species from each sampling location with the intent of identifying the specific species within each trophic level to focus more extensive analyses. Overall, this screening is assumed to be limited to a maximum of 25 species across all trophic levels. Screening analysis will consist of analysis of muscle for  $^{137}\text{Cs}$  and  $^{90}\text{Sr}$  and analysis of corresponding skeletal material for the full range of isotopes under consideration in this study. The following potential species and trophic levels have been identified for sample collection:

Kelp/Ulva

Chiton/Sea Urchin

Blue mussel/Basket Star/Rock Jingle

Red king Crab/Brown Crab

Ocean Perch

Dolly Varden

Atka Mackerel

Halibut/cod/Pollock

Eagle

Gull/Puffin

Eider/guillemot

Harbor Seal/Sea Otter

- A. Initially analyze the one within each group with the sample size that most approaches our target (in most cases, the one with the highest sample size).
  - B. Where there are equal sample sizes, select the one that is expected to be the highest accumulator of radionuclides (e.g. top level predators for birds, mammals, fish).
  - C. Where there are equal sample sizes, and no obvious difference in their accumulator qualities, select the one that is a traditional subsistence food or commercially viable.
4. For selection of specific species to focus analysis on (e.g., multiple replicates), the following considerations apply:
- a. One species representative of each of the selected trophic levels will be identified for more extensive analysis. More extensive analysis will consist of
    - i. Up to 10 analysis for each sample location for  $^{137}\text{Cs}$  (soft tissue)
    - ii. Up to 4 analysis for each sample location for  $^{90}\text{Sr}$  (soft tissue)
    - iii. Up to 4 analysis for each sample location for remaining isotopes of interest (e.g., U and Pu series,  $^{99}\text{Tc}$ , other isotopes of interest) in skeletal material
  - b. Priority for selection of species for analysis will be based on:
    - i. Human health risk, if above a nominal minimal threshold of  $10\text{E}-6$  excess cancer risk if consumed at a rate of 300 kg/yr for 75 years.
    - ii. Information about isotope sources based on measurable U and Pu isotope series.
    - iii. The following algorithm would be used for assigning priority within a given trophic level:

$$\textit{Priority number} = \log(10 \times \text{human health risk}) / (10\text{E}-6) + (\textit{Pu information} + \textit{U information})$$

Under this approach, the larger the *priority number*, the higher the priority for the more extensive analysis of the species within the designated trophic level. The human health value would equal 1 for a  $10\text{E}-6$  risk level. The *Pu information* would equal 0.5 if characteristic Pu isotope ratios are measurable. The *U information* would equal 0.5 if the characteristic U isotope ratios are measurable. Thus, the value of the source information would be equal to either 0, 0.5 or 1). Tie values would favor human health if

the risk value was greater than 10E-6 and would favor source information if the risk value was less than 10E-6.

- iv. Measurement of Pu isotope ratios can be used to provide an indicator of whether the source of contamination was from a nuclear test shot. Measurement of U isotope ratios can be used to provide an indicator of whether the source of contamination was from enrichment or reactor accidents or discharges. Absence of information on these ratios does not support that the source of contamination was not from one of these causes.
5. In total, approximately the following numbers of analyses can be completed within our current budget:
- a.  $^{137}\text{Cs}$  – 600 (20% at INEEL, 80% at VU)
  - b.  $^{90}\text{Sr}$  – 200
  - c. Other isotopes – 200
  - d. These numbers will be refined after trial runs and validation of all analytical measures.
  - e. Reductions in gamma counting times will allow for more  $^{137}\text{Cs}$  samples to be analyzed (this would be the case if baseline levels are elevated enough to get detectable values with shorter counting periods).
  - f. Fewer screening analyses would allow for more replicates focused on specific species.