Summary of SSC Comments and Recommendations from July 23-24, 2009 SQO Meeting

Technical presentations on July 23 focused on technical aspects of applying the tiered assessment framework as recommended by the SSC during its previous meetings.

- Steve Bay reviewed the purpose of the tiered SQO assessment and described a proposed approach to conducting a site assessment. This approach includes two principal steps. The first step is to interpret the tissue and sediment chemistry data (i.e., lines of evidence) to address the two main assessment questions: "Do seafood tissue concentrations pose an unacceptable risk to human consumers?", and "What is the contribution of sediment contamination at the site to the tissue contamination of concern?" The recommended data interpretation approach for this step would combine the concentration data and variations in consumption rate to result in multiple categories of interpretation of each question (e.g., very low to very high). The second step of the proposed assessment approach is to combine the two lines of evidence into a site assessment that consists of multiple categories. Several methods to combine the information were presented, including a sequential approach in which the seafood line of evidence is heavily weighted and an integrated approach where each line of evidence potentially contributes to each of the final assessment category results.

- Ben Greenfield presented an update on the development of the Decision Support Tool (DST) and the results of sensitivity analyses of the bioaccumulation model. Refinements to the tool have been made to facilitate data entry of multiple contaminants and to allow the model to be applied to various fish and shellfish species of interest to stakeholders. Graphical display of the model output and a capability to incorporate a site use factor have also been added. Monte Carlo simulations were used to evaluate the sensitivity of the results to variations in several model parameters. Sediment organic carbon, tissue lipid, prey lipid, and the proportion of benthic diet were identified as the most influential parameters in the model.

- Ben Greenfield also described several approaches for expressing variability in the bioaccumulation model results. Variability in four types of data could be addressed in this program: consumption rate, tissue chemistry, sediment chemistry, and BSAF (as determined by the bioaccumulation model). Three options to address variability in the analyses were described: 1) Use only measures of variability in chemistry data that are derived from site-specific analyses; 2) Estimate multiple values of each of the four data types from distributions and use each independently in the assessment analyses; 3) combine the distributions of chemistry, BSAF, and consumption rate into an overall distribution of exposure that is used in the assessment analyses.

- Two members of the SQO Advisory Committee presented results of preliminary case studies using the DST. They found the DST relatively easy to use and it was useful in investigating sediment contamination issues at sites in the San Gabriel River estuary and San Pedro Bay. Issues of concern included a lack of guidance regarding chemistry data preparation, how to "average" data for key parameters over a large site area, how to make estimates for non-standard model parameters (such as % prey lipid, % benthic diet) that would require special study to derive on a site-specific basis, and how to handle "non-detect" data. For example, many of the common approaches for handling "non-detect" data (e.g., using 0.5 of the detection limit) often resulted in most sites being directed to Tier II. For PCBs and toxaphene, even data with all non-detect values would be directed to a Tier II analysis.

The SSC met in closed session on July 24 to review the information presented and develop recommendations for the Science Team.

The SSC reviewed the objectives of the indirect effects (IE) assessment program:

- Use a modeling approach to estimate seafood concentrations.
- Emphasize seafood consumption risk as the basis for rish in the approach.
- Model is used to estimate sediment linkage to tissue contamination, not to confirm total tissue concentration at site.

The committee identified their top issues for discussion:

- How to address variability and uncertainty:
  - The SSC suggested idea of carrying/using confidence limits of tissue chemistry into the interpretation. Puts onus on user to make a decision and motivation to collect better data. It was pointed out that the approach just considers variability, not uncertainty
  - There are many sources of uncertainty. One can use sensitivity analyses to identify important parameters contributing significantly to uncertainty about the prediction of risk that warrant quantitative uncertainty analysis.
  - It might be helpful to consult a recent paper (Burkhard et al. *in press* ETC) on empirical BSAF variability to determine which are important parameters to use in uncertainty analysis
  - A graphical approach was suggested for interpreting sediment chemistry data variability with respect to the size of the site and the forage area of fish (see attached). This might be a useful way to convey risk assessment results including the uncertainty to user. The SSC will develop a more specific example to illustrate the approach. This may help determine whether it could be used in one of the Indirect Effects assessment tiers

- How to simplify the process for the user:
  - It may be appropriate to limit fish and shellfish species selection to most important ones or use guilds.
  - It may be appropriate to limit the variables that can be adjusted by the user to just those that are primarily important (e.g., TOC, fish lipid content) and to "fix" values of less important or harder-to-measure parameters (e.g., salinity, temperature, DO, % benthic diet)
  - It may also be easier to use simple predetermined BSAF values for Tier 1 application. These BSAFs would be developed using same model approach (not empirical) as for later Tiers. Check out Burkhard et al. (*in press* ETC) for applications

- This issue of how to simplify the process will likely expand as more specific technical issues are resolved and it becomes more clear where simplification can be applied without compromising the process

- Is a fish and shellfish to sediment model (reverse direction) needed in this process?
  - This topic was briefly discussed but tabled as this can be developed later with updates to the process but the committee thought this could be useful in the future.

- How to relate calculations of hazard to categorical assessment result? Is it appropriate endpoint?
  - Greater specificity is needed for what matrix cells represent. The matrix cells should be answers to a question. The science team is directed to clarify both the questions and the answers represented by the matrix cells.
  - Basic rationale and approach presented in the meeting appears to be feasible, Science Team should continue to develop the details

  Role of consumption rate variations in the assessment is primarily a policy issue. Science Team should investigate the impact of consumption rate to assist Water Board in making this policy decision. To assist the science team, the SSC will develop a series of graphical displays that will demonstrate the issue and may be of use for the decision points with either fish and shellfish tissue concentrations or model estimated fish and shellfish tissue concentrations (see attached).

- What data quality guidance is needed (e.g., PCB congeners, detection limits):
  - The SSC confirmed that Tier 1 can be answered solely on fish and shellfish tissue data assuming the fish and shellfish data are of high quality and representative of the site. The characteristics required of the data should be investigated by the Science Team.
  - Fish and shellfish species used should have strong sediment linkage and site fidelity
  - Guidance/species list should be developed
  - Identify a short list that reflects consumption patterns and have sediment connections and the list may be different in different geographical portions of the State.
  - Guidance is also needed on integration of site data with respect to variability and species. Use of composite samples may be beneficial, should check with existing State policy. The theory is that individuals are actually consuming some average value. However, it should be recognized that such compositing does tend to reduce observed variability. The use of fish and shellfish sampling and measurement should strive for compatibility with other State policy

- What data should be required for a site; what is an appropriate sample for Tier 1 vs Tier 2 analysis:
  - Science Team needs to provide guidance on interpretation for users
  - Data used should meet some minimum standards of spatial representativeness and quality for all tiers

  - Site sediment TOC should be required for all Tiers (i.e., default values are not to be used)
  - Use of existing fish and shellfish advisories is not recommended because (1) the advisories might have been initiated based on chemicals that are not among chemicals of concern at the site of interest and/or risk thresholds that differ from the risk levels of concern to the Science Team, (2) the advisories might be based on fish and shellfish data that were collected outside of the site under consideration and do not reflect site conditions, and (3) other study design and data issues that might limit the applicability of an advisory to a specific site.
  - Multiple "conservative" assumptions could be used for Tier 1. However, these assumptions are mostly policy issues and the SSC can't provide specific science based recommendations without seeing the results of case studies/sensitivity analyses
  - The use of multiple conservative assumptions particularly in Tier 1 but also to some extent in Tier 2 has the potential for generating false positives. The SQO policy should incorporate approaches that will recognize the issue and provide guidance on the approach to resolve it.
  - The SSC also discussed the option of a probabilistic analysis, where we consider explicitly the variability in various factors (consumption rates, tissue concentrations, human body weight, etc.). We discussed Monte Carlo-type approaches as one option. A probabilistic approach would allow development of "risk curves" and evaluate how likely specific outcomes might be, to judge just how conservative a multiple-layering of conservative assumptions would be.

  For Tier 1, it may be appropriate to assume benthic-associated fish in short list are consumed 100% by angler. Also, that the fish spend 100% of their forage time at the site. It was also pointed out that consumption rates are based on total consumption and that consumption at a site may not be 100% however using the assumption of 100% consumption from site is the most conservative.

- How is a site defined in the process and how are data summarized? Case studies seemed uneven:
  - Guidance needs to be provided for study/analysis design to make sure data used in model/assessment are representative
  - Information on regional background levels of sediment contaminants and associated tissue bioaccumulation are needed to provide interpretation context. Technical support should include guidance on how to interpret model results from smaller sites relative to nearby areas.
  - The SSC also briefly discussed the utility of trends in time, esp. as indicated by short-lived, local forage fish to assist in determining the potential for ongoing changes in the sediment condition and the resultant impact on fish concentrations.
  - There are alternative methods for dealing with non-detect data than were presented in the case studies. The Science Team should review approaches described in recent EPA and Corps publications and provide recommendations

The SSC also provided general comments and clarifications on the tiered assessment framework:

- The purpose of Tier 1 is to answer the questions: Is there a human health (HH) risk and could sediments be contributing to this HH risk? The purpose of Tier 2 is to answer the question: How much are sediments contributing to HH risk?
- The consumption rate or rates used in the assessment is a policy decision that should be determined by the Water Board.
- It would be helpful for the SQO policy to provide high level guidance on the use of the tools for policy application such as the design of TMDL/cleanup programs indicating the appropriate uses of assessment framework in this context. Likely such guidance should include examples and/or case studies for all the different applications for the assessment framework. This recognizes that the assessment framework is only part of the policy and that management decision makers need to understand the strengths and limitations of the assessment approach for appropriate application outcomes.
- A specific assessment outcome should not be used to determine a specific management outcome. The purpose of framework is not to decide what management actions are needed (that would require a massive amount of additional work by the Water Board to develop policy).
- There are other classes of contaminants for which the current model approach is inappropriate (e.g., metals, metabolized organics). The framework will have to use different model approaches if/when SQO scope is extended to other chemical types.
- The current version of the model used in the DST may not adequately reflect the role of higher trophic level piscivorous species. The science team should check to make sure this issue is addressed.

SSC confirms that use of empirical SQGs, like ERLs, are inappropriate to apply as management thresholds for indirect effects. More specific analyses that take into account bioaccumulation and the mode of toxic action are needed to develop management thresholds.

The SSC wants to thank Susan Paulsen for representing the Advisory Committee in Brock Bernstein's absence and for her contributions to the discussion and comments on the notes.

Action items:

1. CharlieMenzie: will develop spatially-dependent uncertainty approach and send out his suggestions to the SSC (attached).

2. Jim Shine: Will work with information provided by Ben to illustrate impacts of variability in fish and shellfish consumption and tissue contamination on risk for target contaminant groups for SQO (attached).

3. SSC will review additional materials by email and conference call in next few months. Will likely need another face-to-face meeting in early 2010 to review next iteration of work.

Addendums:
Attached are the action items that were described above to be provided by Jim Shine and Charlie Menzie.

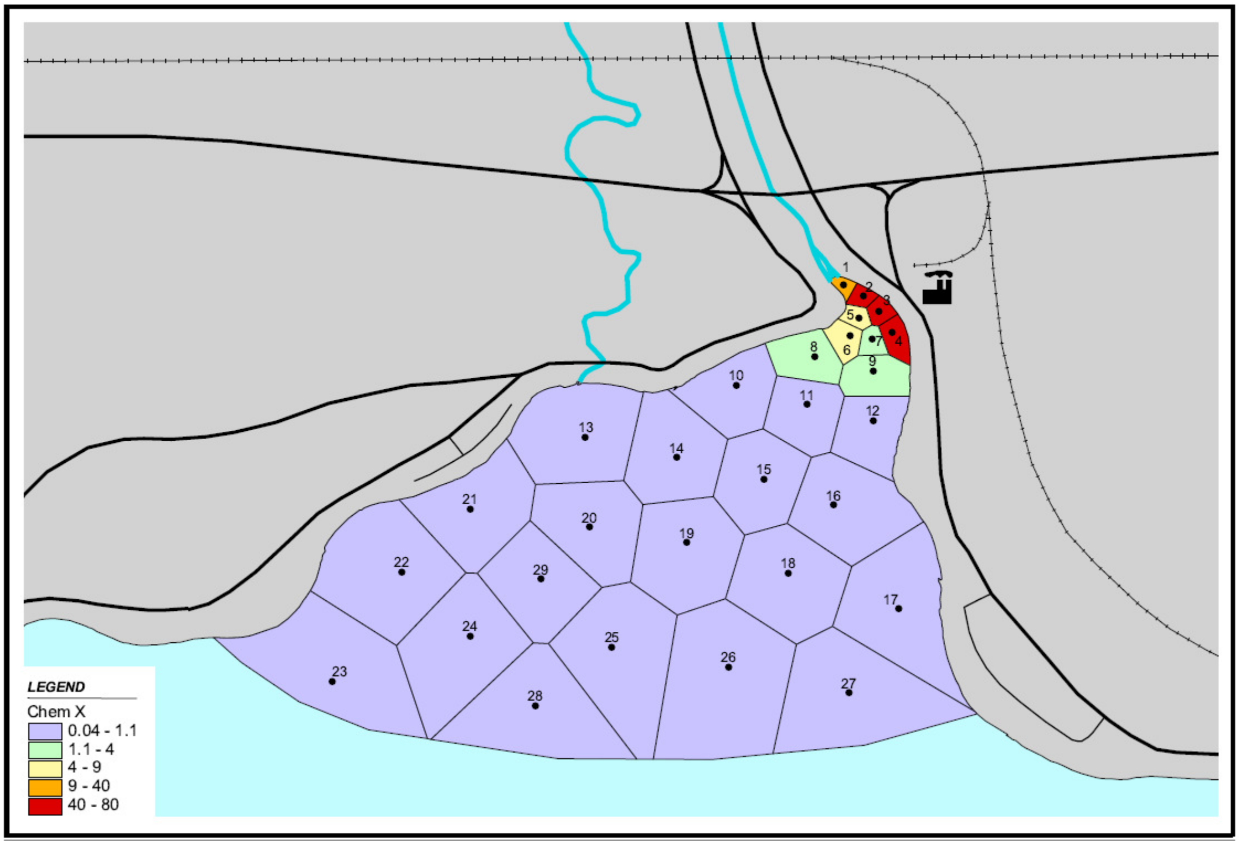
1. Example(s) of incorporating area into the evaluation of SQOs.
C. Menzie

Premise:
Exposure of people to contaminants in fish that are the result of exposure to contaminants in sediments arises through bioaccumulation and transfer of those contaminants.
Recreational fishing will most likely result in long-term exposures to some metric that reflects the central tendency of the fish population being caught by the anglers.
If sediments are an "important" contributor to the contaminants in fish tissue, then the fish population as a whole will reflect the central tendency of exposure to the sediments.
The central tendency of the contaminants in fish associated with sediment-related exposures is related to the weighted-average concentration of the contamination in the sediments in the "area of interest".

Things that are set for the analyses and that do not need to be calculated on a case by case basis:
State technical policy decisions related to risk target levels and exposure assumptions (primarily consumption). These can be used to derive concentrations in fish that relate to the specified risk levels and consumption rates. There is no need to do this exercise again and again on a case-specific basis. A simple table can be constructed and used for all cases for a select set of fish species that represent the recreational market and that are related directly or indirectly to sediments. NOTE: consumption rates would need to be developed for these from existing data. This would not be done by the user. Instead, policy decisions would be made on how to derive these and the associated target levels. This is a Science Team matter.
Type of fish that comprise a large fraction of the recreational fishery on a biomass basis. This can be derived by the Science Team from existing information.

BSAFs for fish tissues can be derived using a combination of literature values, models, and existing California experience.
BSAFs for the selected species will fall within a range. This can be seen from Ben's modeling efforts and is the basis for lots of literature reviews and compilations. Therefore, these values can be a useful first (or second) step for deriving fish concentrations. Because we are interested in values that yield a central tendency value, we are not interested in the extremes (i.e., what might occur in an individual fish or model run) but in the band that captures most of the possibilities. When Ben's modeled values are transformed to means, the range collapses greatly. Therefore, this should be relatively easy to derive from existing information. I think we can define a band that captures most of the uncertainty in the estimate of the mean or median. This band is narrower than that for all fish (i.e., as individuals).

The approach beginning with measures of contaminants in sediments.
Consider the case presented below:
<u>Step 1 plot the sediment data and generate Thiessen polygons</u>



This is a simple case (we can do more complex ones) wherein sediment samples were collected throughout an embayment. Some sediment locations are close together and some are farther apart. The concentration of chemical X is shown in color and ranges from 0.04 to around 80 ug/kg. (I have not named the chemical in this example so as not to distract from the analysis.)

The example shows the stations. The collection of stations has been used to generate a set of Thiessen polygons. Each polygon has an associated sediment concentration and a defined area. With this combination we can now examine exposures that take into account the spatial ext6ent of the contamination. The data for the above example is presented below.

Tabular data for example

ID	Area (ft2)	Acres	Chem X conc ug/kg
1	62,626	1.4	40
2	86,595	2.0	65
3	105,312	2.4	80
4	183,556	4.2	70
5	100,266	2.3	9
6	199,613	4.6	9
7	122,308	2.8	4
8	560,700	12.9	2
9	482,763	11.1	1.8
10	1,096,449	25.2	1.1
11	875,340	20.1	0.6
12	860,545	19.8	0.8
13	2,017,273	46.3	1
14	1,572,717	36.1	0.3
15	1,317,685	30.3	0.5
16	1,701,313	39.1	0.5
17	2,269,867	52.1	0.7
18	1,854,843	42.6	0.2
19	1,853,925	42.6	0.3
20	1,581,871	36.3	0.2
21	1,721,218	39.5	0.1
22	2,464,408	56.6	0.18
23	2,804,709	64.4	0.12
24	2,208,037	50.7	0.08
25	2,491,277	57.2	0.16
26	3,205,042	73.6	0.04
27	2,719,303	62.4	0.14
28	2,326,781	53.4	0.06
29	1,490,910	34.2	0.07

Step 2. Rank Thiessen polygons by concentration and calculate weighted-average sediment concentrations

Polygon ID	Area (ft2)	Acres	Cumulative area	Chem X conc	Area-weighted sediment concentration for cumulative area
3	105,312	2.4	2.4	80	80
4	183,556	4.2	6.6	70	73.65
2	86,595	2.0	8.6	65	71.65
1	62,626	1.4	10.1	40	67.12
5	100,266	2.3	12.4	9	56.31
6	199,613	4.6	16.9	9	43.52
7	122,308	2.8	19.8	4	37.89
8	560,700	12.9	32.6	2	23.73
9	482,763	11.1	43.7	1.8	18.17
10	1,096,449	25.2	68.9	1.1	11.93
13	2,017,273	46.3	115.2	1	7.54
12	860,545	19.8	134.9	0.8	6.55
17	2,269,867	52.1	187.1	0.7	4.92
11	875,340	20.1	207.2	0.6	4.50
15	1,317,685	30.3	237.4	0.5	3.99
16	1,701,313	39.1	276.5	0.5	3.50
14	1,572,717	36.1	312.6	0.3	3.13
19	1,853,925	42.6	355.1	0.3	2.79
18	1,854,843	42.6	397.7	0.2	2.51
20	1,581,871	36.3	434.0	0.2	2.32
22	2,464,408	56.6	490.6	0.18	2.07
25	2,491,277	57.2	547.8	0.16	1.87
27	2,719,303	62.4	610.2	0.14	1.70
23	2,804,709	64.4	674.6	0.12	1.55
21	1,721,218	39.5	714.1	0.1	1.47
24	2,208,037	50.7	764.8	0.08	1.37
29	1,490,910	34.2	799.0	0.07	1.32
28	2,326,781	53.4	852.5	0.06	1.24
26	3,205,042	73.6	926.0	0.04	1.14

This step is accomplished with a spreadsheet. The polygons are ranked by concentration. The rest of the spreadsheet calculates the area-specific and weighted-average sediment concentrations. This step is the key aspect of bringing scales into the evaluation.

Step 3. Translate sediment concentration into a visualization of potential fish concentrations.

This step involves using the pre-derived BSAF values that are specific to a type of fish. The premise is that once these are established for the SQO documents, they do not have to be repeated on a case-specific basis. All that needs to be known (if desired) is TOC. So the user is not required to figure out modeling inputs. Also, the desired BSAFs are central tendency estimates not the range in individual fish. This is in keeping with long-term exposures associated with sampling (catching fish) from the population. For this example, I will use an estimate of 5 for the lower end of the BSAF and 10 for the higher estimate. This band reflects the uncertainty associated with such estimates and is a simple way of bringing that uncertainty into the analysis. The resultant fish concentrations are shown with cumulative area below. These calculations are all implemented with a simple spreadsheet. A segment of that sheet is provided below.

Cumulative area	Area-weighted sediment concentration for cumulative area	Average fish conc. With area at Lower BSAF estimate of 5	Average fish conc with area at higher BSAF estimate of 10
2.42	80.00	400.00	800.00
6.63	73.65	368.25	736.50
8.62	71.65	358.27	716.53
10.06	67.12	335.61	671.22
12.36	56.31	281.53	563.07
16.94	43.52	217.58	435.17
19.75	37.89	189.47	378.94
32.62	23.73	118.66	237.32
43.7	18.17	90.86	181.71
68.87	11.93	59.66	119.32
115.18	7.54	37.68	75.37
134.94	6.55	32.75	65.50
187.05	4.92	24.60	49.20
207.15	4.50	22.51	45.01
237.4	3.99	19.96	39.91
276.46	3.50	17.49	34.98
312.56	3.13	15.64	31.29
355.12	2.79	13.95	27.90
397.7	2.51	12.56	25.12
434.01	2.32	11.59	23.19
490.59	2.07	10.36	20.72
547.78	1.87	9.36	18.73
610.21	1.70	8.48	16.95
674.6	1.55	7.73	15.45
714.11	1.47	7.33	14.65
764.8	1.37	6.87	13.73

799.03	1.32	6.59	13.17
852.45	1.24	6.19	12.39
926.03	1.14	5.72	11.43

Step 4. Select pre-determined target levels for comparisons

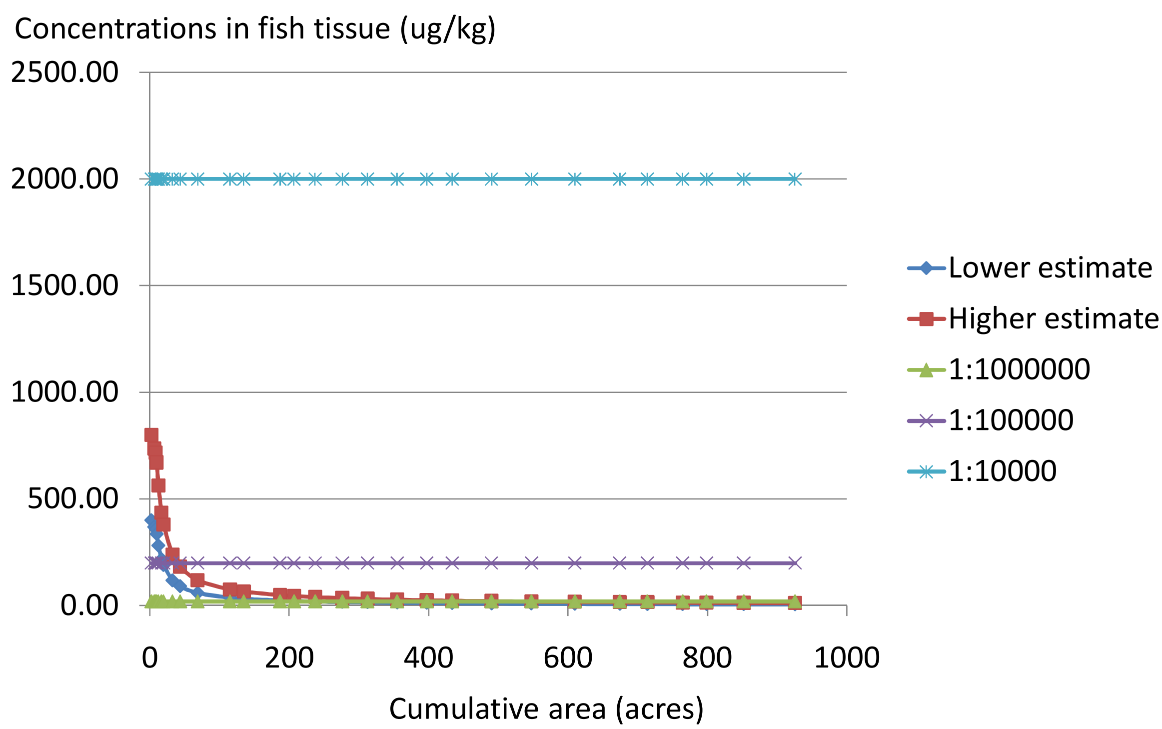
Our chemical X is considered a carcinogen and the slope factor, consumption rates etc. are all set by technical policy and do not have to be entered by the user. Instead, for all the compounds of interest it is already possible for the Science Team to prepare a table of target values for the contaminants in fish. With a simplification, this can also be now done for total PCBs (not covered here). My example will use the cancer risk values 10-4, 10-5 through 10-6 as targets. For purposes of this example, I use the term high, moderate, low to convey meanings related to where predicted or actual fish body burdens fall. Note, the use of pre-determined target concentration in fish will eliminate the need of the user for making and interpreting risk calculations. I do not see these pre-determined levels for fish tissues as the same as a look-up table for sediments. The former is always the baseline for comparison; the latter if case specific. For chemical X, the tissue levels for recreational anglers are as follows:

10-4 cancer risk – 2,000 ug/kg wet wt

10-5 cancer risk – 200 ug/kg wet wt

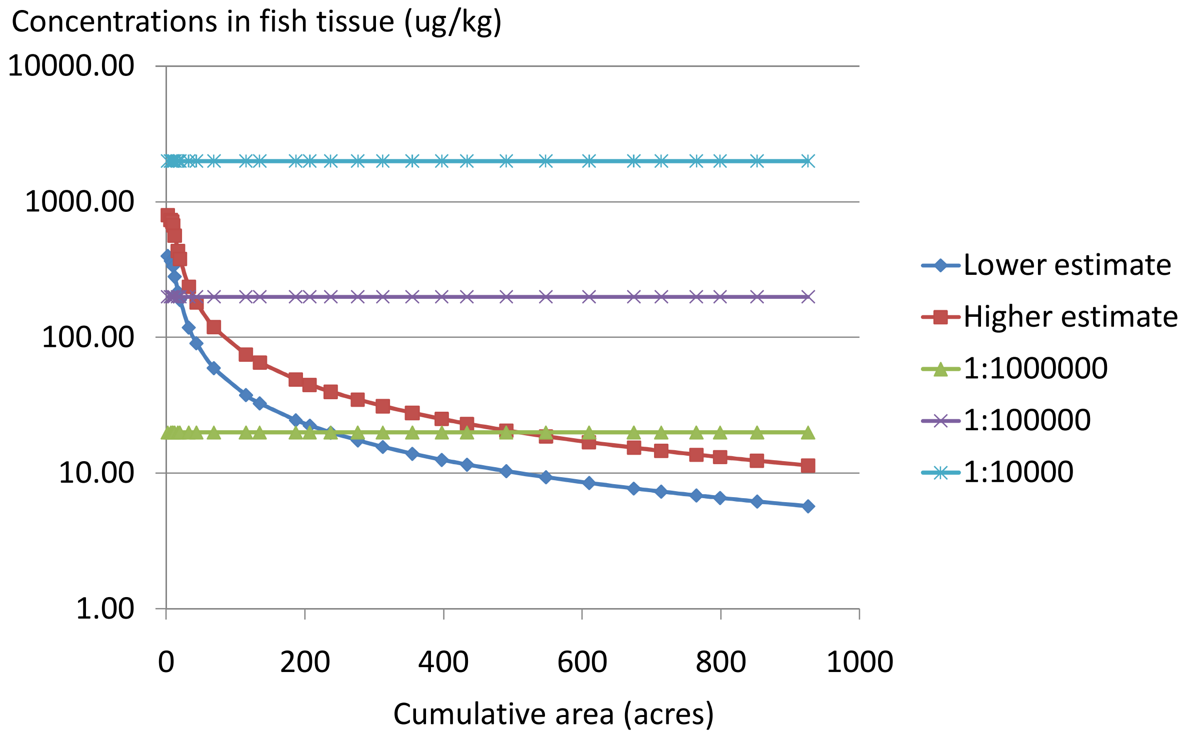
10-6 cancer risk – 20 ug/kg

Step 5 Display estimated tissue levels against the three target levels from Step 4.
The figure below shows the relationships between weighted average concentrations in fish (reflecting sediments) and target levels. This is the linear view:

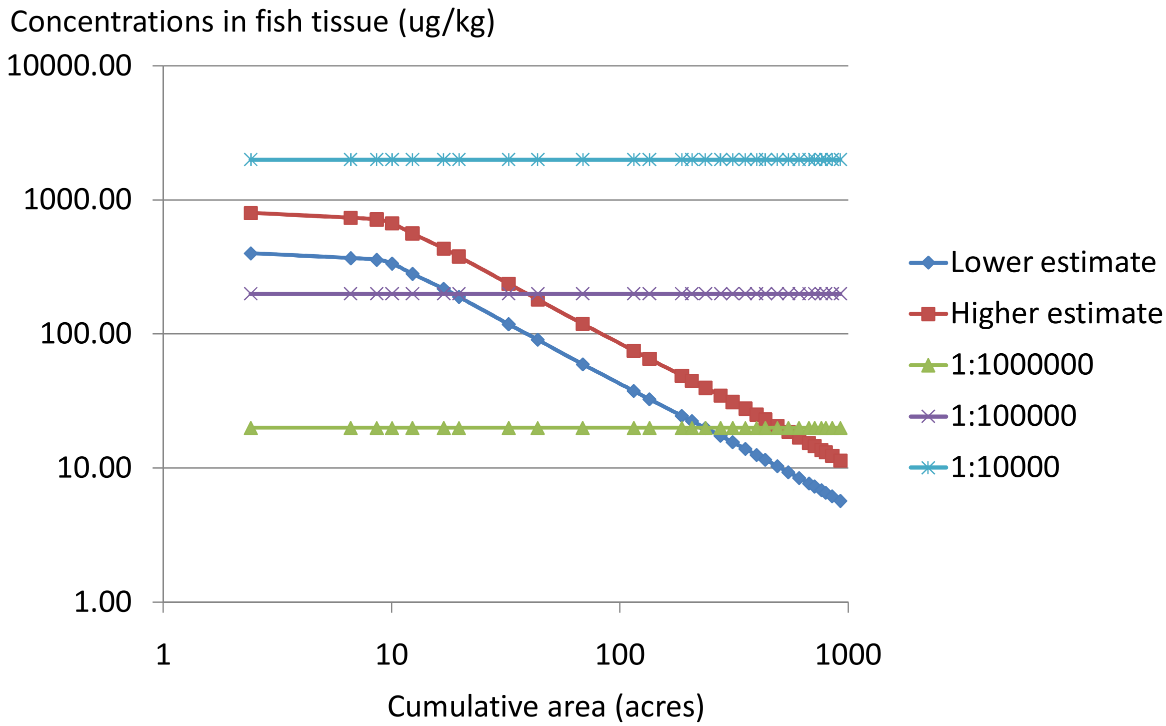


Comparison of estimated average fish tissues of Chemical X (lower and higher bounds) to pre-determined risk-based target levels for Chemical X in fish.

The following figure shows this at log scale. This is the scale that would prove most useful for these assessments for seeing detail.



Comparison of estimated average fish tissues of Chemical X (lower and higher bounds) to pre-determined risk-based target levels for Chemical X in fish (log scale for concentrations). The scales of the fish and/or fishing are not explicitly shown on the above figure is that associated with either the region of fishing or the region of foraging for the local population of this fish species. If known, that can be included. The following log-log plot shows how the detail can be conveyed to provide insight into smaller as well as larger spatial scales.



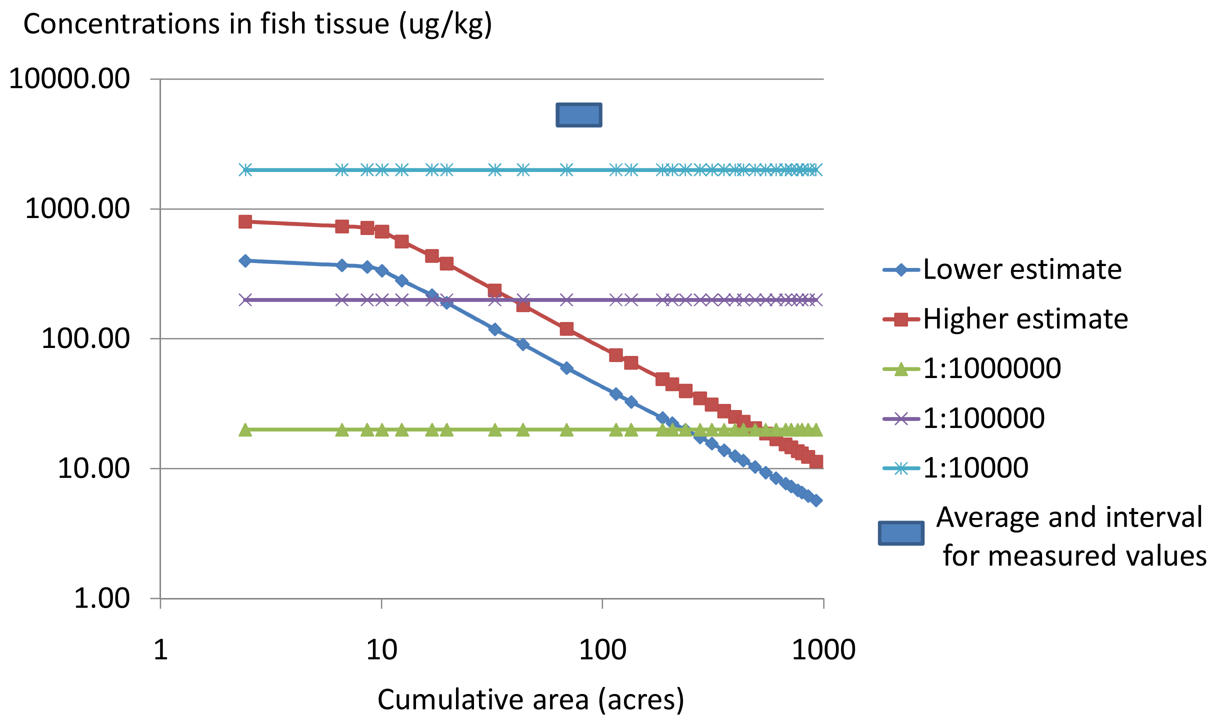
Comparison of estimated average fish tissues of Chemical X (lower and higher bounds) to pre-determined risk-based target levels for Chemical X in fish (log log scale for concentrations and area).

The figure presented above can be interpreted in the following ways. There are no estimated risks that exceed 1:10,000 in this example. There is moderate potential risk at scales up to 20 to 30 acres. If we knew that this was an area large enough to support a local foraging population of fish, we would conclude that the estimate indicates a moderate risk level. The figure shows that at larger scales, risks are either low or negligible depending on the area over which fish or fishing is averaged. Finally, if a subsequent assessment tier involving the collection of fish shows that there is high confidence that sediments are contributing to the risk, the graphic can be used to focus on those areas (polygons) where exposures risks can be most effectively reduced. If, for example, we wished to reduce risks to below 1:100,000, than there is an area less than 10 acres that would be of primary focus.

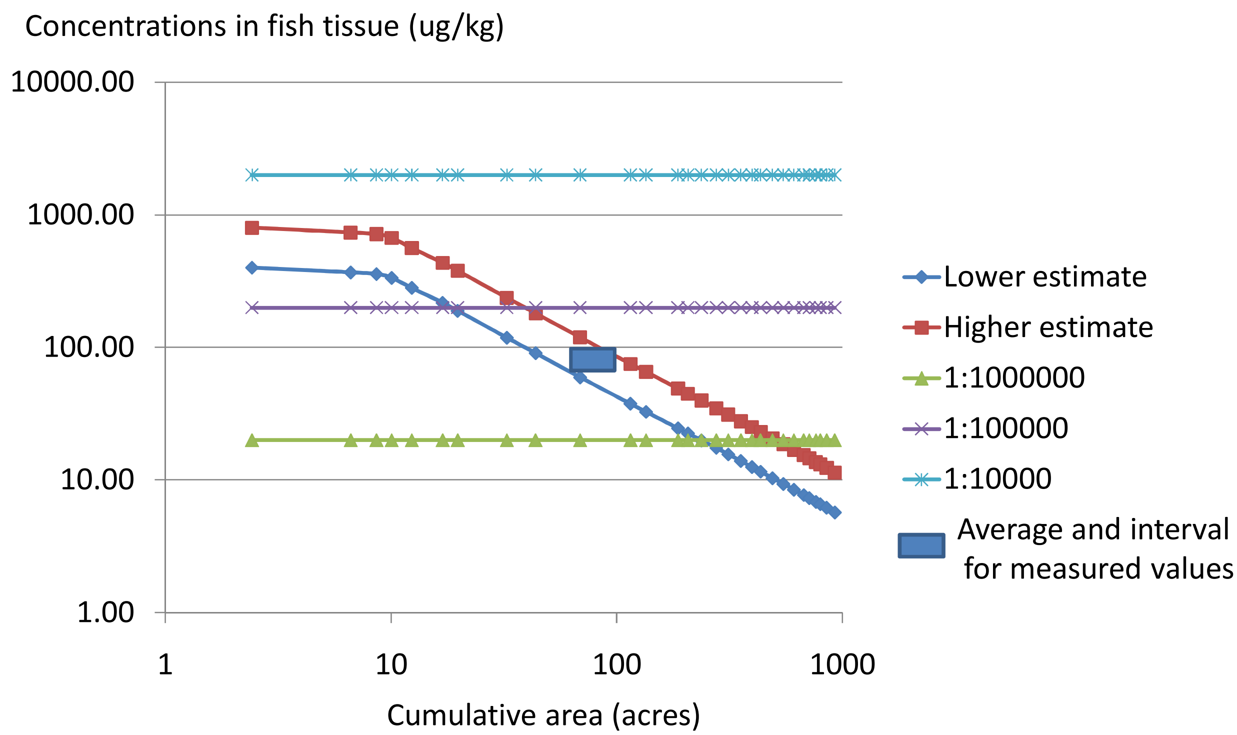
Comparing actual concentration for a particular fish species and chemical

In the following three pictures I illustrate the more complete analysis that involves comparing the measurements of fish tissues to our graphic. I suggest an initial interpretation. This initial interpretation would be the basis for subsequent evaluation. For this exercise, I suggest we place the summary for measured fish at a scale appropriate to what we believe to be the scale for their exposure. In the current example, I am assuming that is 100 acres. The width and the height of the box capture uncertainty about the measurements of average (confidence interval) and uncertainty about scale. I use means because we are comparing means all the way across the board.

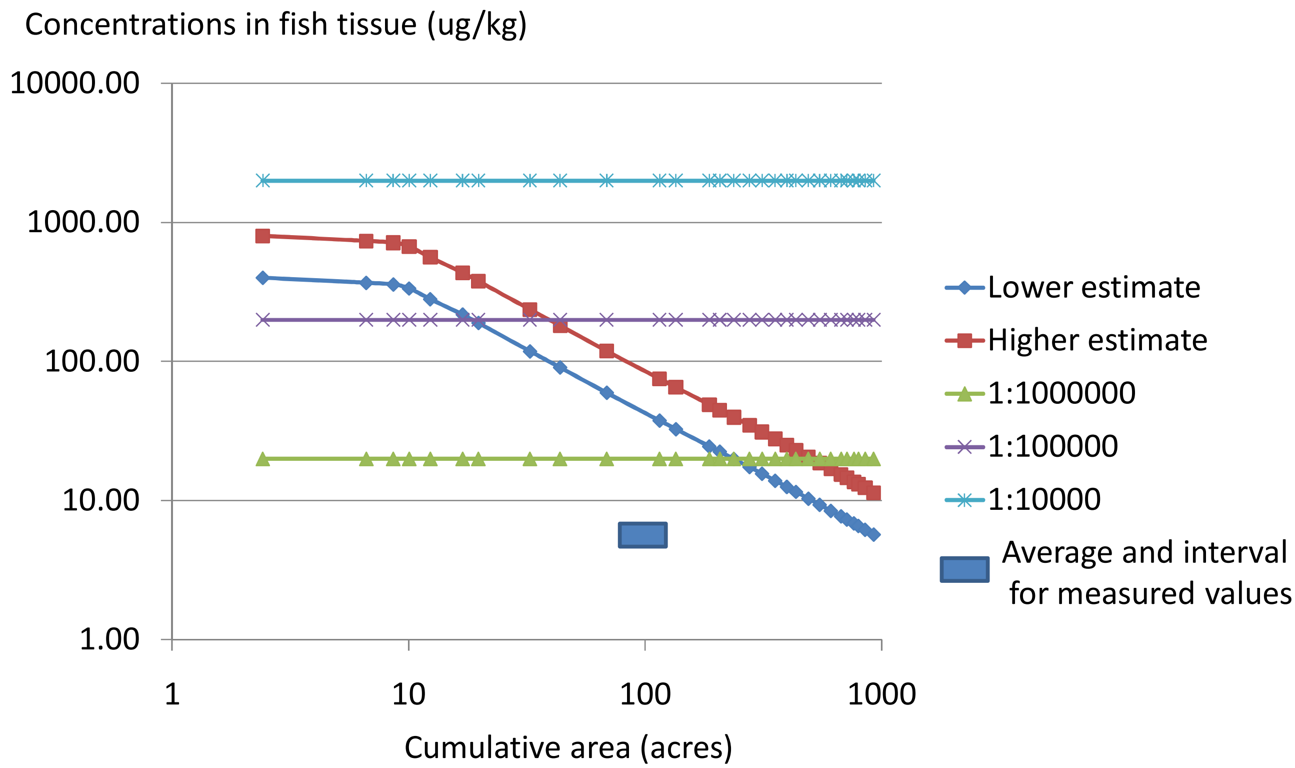
Case 1 average fish tissue greatly exceeds the risk levels. Interpretation is that the sediment that is being evaluated is not the major contributing factor. More analysis is needed to identify the sources. These might include the sediments in addition to other sources, water column, and/or another location.



Case 2 average fish tissue falls within predicted risk levels. Interpretation is that the sediment is contributing to the observed levels of chemical X in tissues and is a likely a contributing factor for those risk levels.

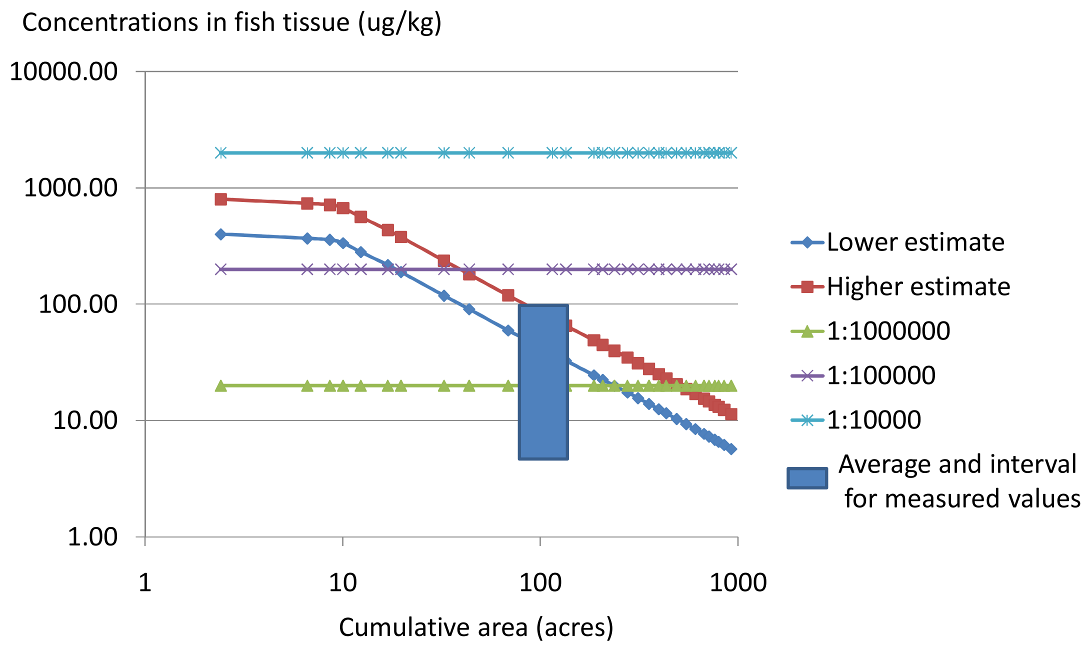


Case 3 average fish tissue falls below predicted risk levels. Interpretation is that the sediment is not contributing to the observed levels of contaminants in fish. This may because exposure assumptions are overly conservative or that the chemical bioavailability is greatly reduced.

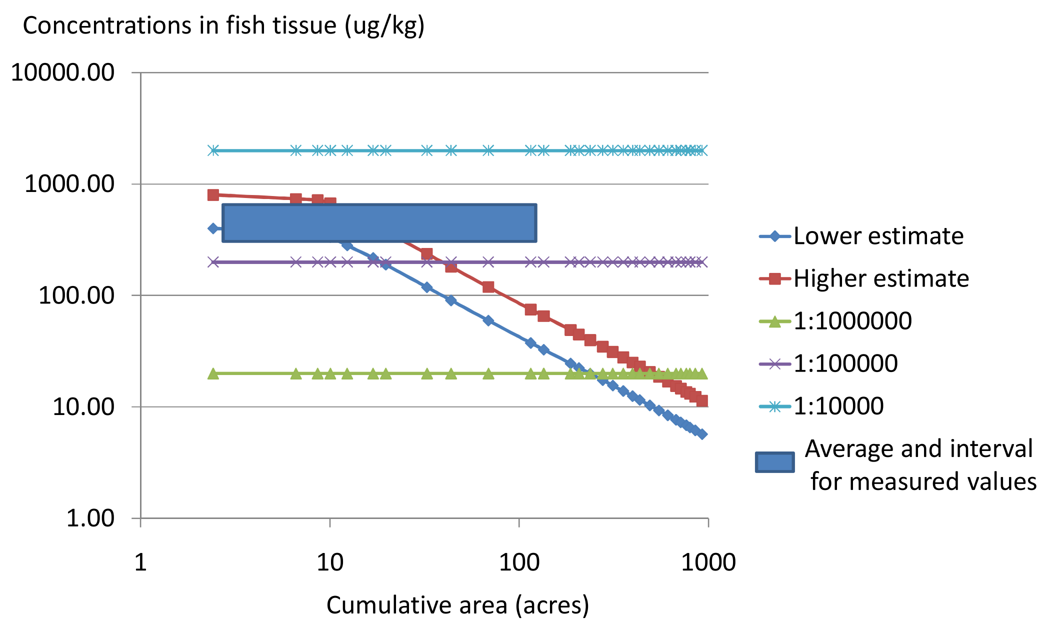


Further examples of portraying uncertainty
The graphic method can be used to illustrate our uncertainties in measurements of the average fish concentration and in our understanding of the appropriate spatial area over which the population forages and is exposed. I give just two examples to illustrate this. These are exaggerated to make the point.

Case 4. Higher uncertainty in the average concentration.



Case 5. Higher uncertainty in the magnitude of the area over which exposure is averaged.



Comments and Questions from SSC on example
The document above begins to address many of the concerns that were expressed in the meeting to incorporate issues of site averaging, uncertainty, species spatial range, and comparison to risk models. The purpose was produce an example that could serve as the output of the tiered approach to serve as a mechanism to incorporate many of the questions that have been provided. The example is hypothetical and is intended to provide a starting point for the discussions and also serve as a type of output that could be useful for evaluating the conditions of sediments at a site. The SSC recommends that the Science Team examine this example and explore the potential of this approach using some of the case study data that are available. The Science Team is asked to examine the questions that are posed concerning this approach to determine the potential impact on application of the approach. Some of the questions will be technical issues, some are alerts that suggest specific guidance will need to be developed and some will have to be relegated to policy.
Several of the SSC have put forward questions some of which are technical in nature and some of which are policy. The questions below are a summary of the discussion so far and it is recognized that more discussion may be required.
Landrum: There is a need to set consumption rates for the examples shown above. As shown by the graphics provide by J. Shine, which is attached to the SSC minutes, the straight lines shown in the examples would represent only a single consumption rate.
Landrum: The consumption rate that is selected for the approach assumes that the consumption will be 100% of target species and does not allow for mixed fish consumption. This is a conservative assumption for a site but should be acknowledged.

Landrum: Portions of the site could be addressed evaluating the potential for contributions to risk on an area basis to provide some insight into the significance of the sediment contamination at specific sub-areas of the site.

Brock: Where did the sampling design come from that was shown in the first figure with the polygons? How different would the answer have been with a different design that didn't have a higher density of stations in the more highly contaminated portion of the map? What sort of guidance could/should the policy include for sampling design, and will this be as vague as the guidance for direct effects sampling?

Brock: Similarly, the last couple of figures illustrating different sources of uncertainty are potentially very useful, but someone could easily game that approach by using greater or lesser levels of sampling intensity. Again, an important concern for the stakeholders will the type of guidance provided to help ensure consistency across assessments.

Tom G.: Echoing Brock's concern about the underlying sampling density and need for guidance.

Tom G.: 2nd being that our region has strongly recommended other means of interpolation as best science (not the Thiessen polygon approach). *The Science Team should develop guidance on the best approach for interpolation of the spatial data for sites.*

Hope: I like spatially explicit approaches and think we should have been doing more of them for longer. So Charlie's proposal is an excellent start. However, I have two thoughts on this.

Hope: First, what kind of sampling program would be needed to support drawing the polygons without too much controversy? Would you be willing to draw a polygon around a single sample, a composite sample, single sample spread through time? I ask this because we've done this for a few terrestrial sites and had several questions like these.

Hope: Second, with respect to risk management, do you want every polygon above the SQO remediated or just have the average of all the polygons be below the SQO (i.e., you only remediate the "hotspots"? Would you be willing to OK a site if only some of the polygons were addressed? I ask this because we had a terrestrial site where, perhaps through miscommunication, we cleaned up to the average rather than overall – the regulated entity was happy, the other stakeholders not so.

Shine: How does one interpret fish data for fish with a home range of 100 acres in a 1000 acre site? An equally important issue is what data will need to be evaluated for a fish with a home range of 1000 acres and a site size of 100 acres.
Landrum: In addition to interpreting the impact of the smaller home range within a large site, the case for the site not being of sufficient size to include the complete home range will also need to be interpreted. This may require the use of the regional background as the contribution outside the site. A comment from Brock on this issue indicates issues such as changing habitat and changing sediment processes may need to be considered.
Shine:

> I am having a hard time figuring out how to use/interpret Charlie's graphs in a final analysis. On the left side of the graph, the predicted tissue concentrations represent a worst case scenario if a fish forages in the most contaminated **"n"** acres of a site. [A slight problem is that there may be multiple hot-spots that aren't contiguous. There was only 1 hot-spot in Charlie's example.] On the right side of the graph where the predicted tissues are truncated due to being at the maximum size of the site, this should approximately represent the average concentration of all fish tissue if they randomly forage throughout the system. I say **"approximately"** because this slightly depends on home range size.
>
> Looking at Charlie's graphs and sticking with the assumption of the 100 acre home range, the predicted tissue concentrations at the 100 acre value should represent a worst case scenario. That is, it is the average concentration for all fish that spend 100% of their time in the most contaminated 100 acres [ignoring the contiguousness issue]. Depending on the area of problematic contamination and the overall area of the site, there may be some fraction of fish that exceed risk thresholds, while the average of fish from the site as a whole do not exceed a threshold. That fraction is related to the ratio of contaminated area to total area. Again using Charlie's example, the average tissue concentrations in fish foraging in the most contaminated 100 acres is approx. 100 ug/kg, while the average conc. of fish at the site as a whole is approx. 10 ug/kg. Depending on how we do the math, only a tiny fraction of fish will be at 100 ug/kg.
>
> Given my understanding, I think the interpretations of Charlie's cases may need some changes in language.

Here is his Case 1:
Case 1 average fish tissue greatly exceeds the risk levels. Interpretation is that the sediment that is being evaluated is not the major contributing factor. More analysis is needed to identify the sources. These might include the sediments in addition to other sources, water column, and/or another location.

I think we mean:
Case 1 average fish tissue levels exceed risk thresholds, but also exceed the highest possible tissue concentration possible at this location given the foraging range. Interpretation is that while contaminants at the site may contribute to the observed fish levels, there may be other sources unrelated to the site. More analysis is needed to identify the sources. These might include the sediments in addition to other sources, water column, and/or another location (the **"other location"** is a problem given that the foraging range is less than the total area of the site, so it wouldn't tend to be at other sites)

Original Case 2:
Case 2 average fish tissue falls within predicted risk levels. Interpretation is that the sediment is contributing to the observed levels of chemical X in tissues and is a likely a contributing factor for those risk levels

I think we mean:
Case 2 average fish tissues are of moderate risk, and while the observed tissue levels are possible if all fish forage in the most contaminated 100 acres, given that the site as a whole is 1000 acres, the expected average from the site as a whole would be expected to be lower. While we can't completely rule out the sediments at the site as the likely contributing factor, the likelihood is low.

Original Case 3:
Case 3 average fish tissue falls below predicted risk levels. Interpretation is that the sediment is not contributing to the observed levels of contaminants in fish. This may be because exposure assumptions are overly conservative or that the chemical bioavailability is greatly reduced.

I think we mean:
Case 3 average fish tissue falls below risk thresholds. However, the observed fish tissue levels are consistent with the modeled expected average concentration for the site as a whole, meaning that the sediment contributed a large fraction of the fish contaminants. While the fish do not cause unacceptable risk, the assumptions put in the model for bioavailability or other factors accurately predicted fish concentration.

I haven't thought through clearly about the case where the foraging range is greater than the area of the location, but the interpretations will be somewhat the same.

As for the contiguous issue, there is an alternative to the Thiessen polygons. If we know the Lat/Lon of the stations, we can fairly easily smooth the sediment concentrations over the whole area (by Krieging or other smoothing routines). Then we can have the computer generate hundreds/thousands of contiguous 100 acre foraging patches (or whatever foraging area we like) over the site as a whole to get hundreds/thousands of estimates of fish tissue concentrations. From there we can estimate the mean (hopefully no different from the right side of Charlie's graph in the situation of only 1 hot spot), but more importantly we can get a variance in fish levels. This will address the case 2 scenario above. It will allow us to say, "Yeah, it is theoretically possible that a fish got that risky level of contaminants totally from our site, but it is not bloody likely."

Shine/Landrum Discussion

Landrum: In your case 2, I can't agree with your conclusion that the likelihood of sediments contributing to the fish tissue is low. I would say that it is likely that sediments were contributing to the fish tissue. I cannot see how you can get to a low likelihood for this case. In case three, I would think that the likelihood of contribution would be low since the fish concentrations better represent low concentrations in the site than high concentrations. I certainly need to think about this some more.

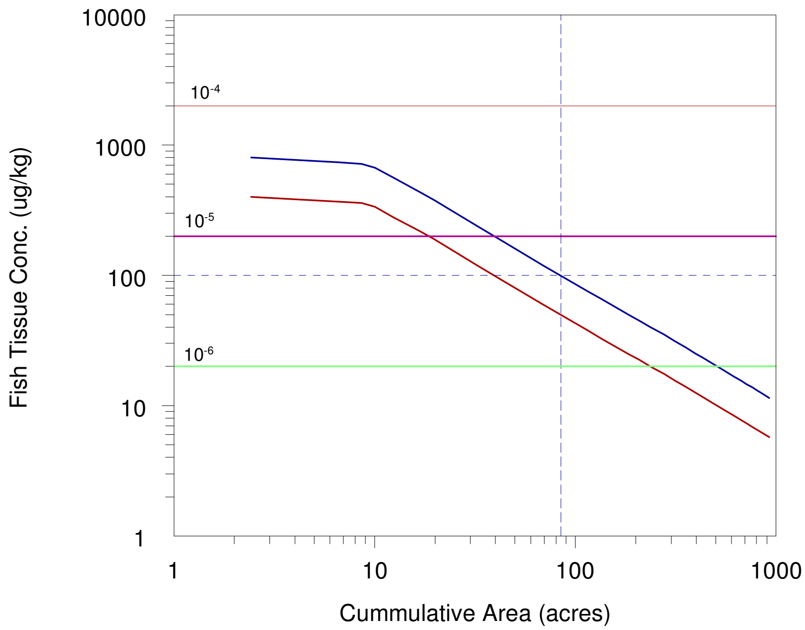
Shine: So back to case 2. The observed fish had a concentration of 100 ug/g. Based on the model, a fish from this 1000 acre site could only have tissue concentrations of 100 ug/kg if it hung out only in the most contaminated 100 acres, which by coincidence exactly matches its foraging area. So while it is possible that a fish at this site could get as high as 100 ug/kg, it's not too likely given the large size of the site. (Note that if the foraging area was less than 100 acres, it might be more possible to get fish to hang out in the contaminated places).

On to Case 3. The observed concentration of 10 ug/g is exactly what our model predicted as a mean for fish averaged over the whole site.

I attached a picture that maybe makes things clearer. It is a re-creation of Charlie's figure. Let's assume for now the BSAF=10 line is the true BSAF. If we sample fish from the site and get a mean of 100 ug/kg, we can draw a line out to the modeled fish tissue line to see how many acres of sufficiently contaminated sediment are out there such that the weighted mean average of sediments in that most contaminated fraction of the site is high is enough to yield a mean fish tissue conc. of 100 ug/kg. In Charlie's Case 2, it turns out that only the most contaminated 85 acres have a weighted running average concentration of contaminants sufficient enough to yield a concentration of 100 ug/kg. Unfortunately, we have a 100 acre fish, so there isn't 100 acres of sediment contaminated enough to get us up to 100 ug/g.

For argument's sake, lets call 85 and 100 within experimental error and therefore the same. So for the Case 2, while there is sufficient area of contaminated sediment to get a 100 acre fish up to 100 ug/kg, it's not by much. There is no room for error. If all the fish don't hang out solely in that most contaminated 100 acres, 100 ug/kg will not happen. That's why I'd say while it is possible for a 100 acre fish to get up to 100 ug/kg given that there are 100 acres (and 100 acres only) of sufficiently contaminated sediment, the site as a whole is 1000 acres. If fish are integrating over the whole area, we would expect the mean to be less than 100 ug/kg. We can do the math to determine the likelihood of a 100 acre fish from this site exceeding 100 ug/kg.

Now if the fish was a 10 acre fish, then yes there is plenty of sufficiently contaminated sediment to get the fish up to 100 ug/kg. The overall mean for fish collected at the site as a whole would be the 10 ug/kg indicated by Charlie's picture, but there may be a higher fraction of fish than before with tissue concentrations higher than 100 ug/kg. We can do the math to figure out this fraction.



Landrum: So what your are saying is that for the case 2 the finding would be the conservative worst case but that is not the same as saying that the sediments have a low likelihood of contributing to the problem. It would seem that sediments could well be contributing as much as was available but that there are other sources. I do understand that should the fish spend an average amount of time at all locations within the site then case 3 becomes the expected prediction. I also agree that case 2 would be the worst case scenario for sediment contribution. Likely the fish concentration should lie between case 2 and 3 depending on the fish behavior. I think I see most of your comment now except for the potential contribution from sediment as being of low likelihood. For it would seem that for a fish in the range between case 2 and 3 would need to have sediment contribution to reach those levels. It would be good to have some exploration with some actual sites and data to see how the interpretation might work out.

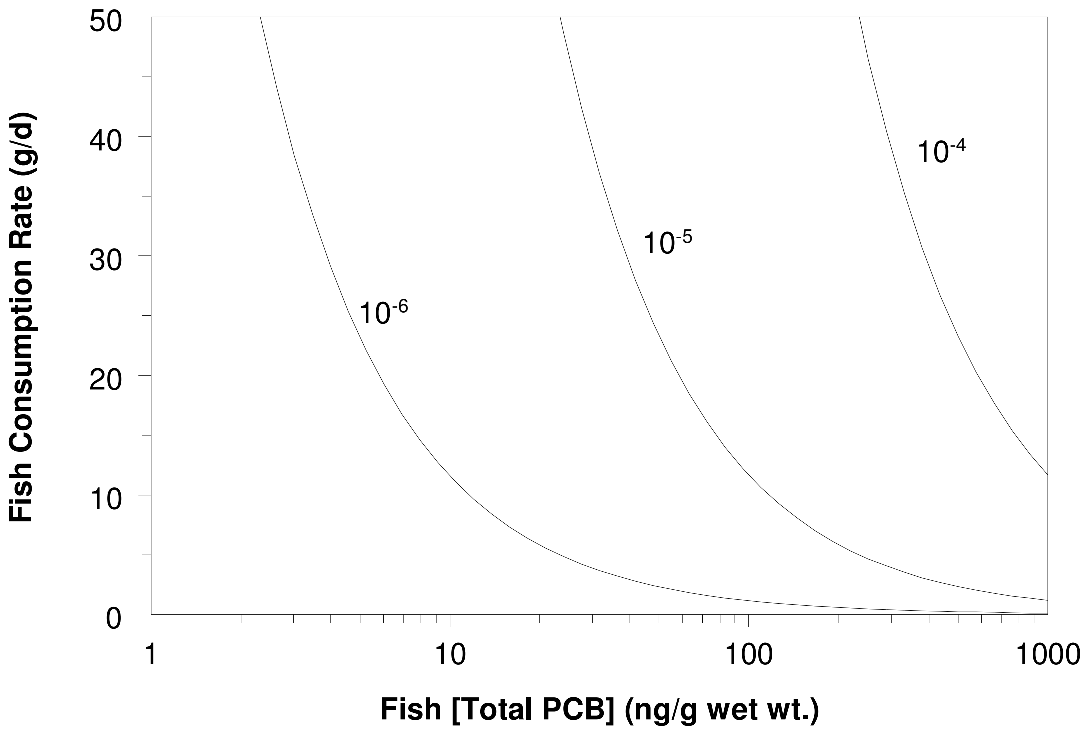
Shine: Yes, I agree. In Case 2, there are some sufficiently contaminated sediments that could have contributed to the observed level in the fish. However, I still doubt that the sediment at this site contributed all 100 ug/kg worth of contaminants seeing as how we have a 100 acre fish in a 100 acre site with only 100 acres of sufficiently contaminated sediment. We are both making sure the language used in the interpretation is correct.

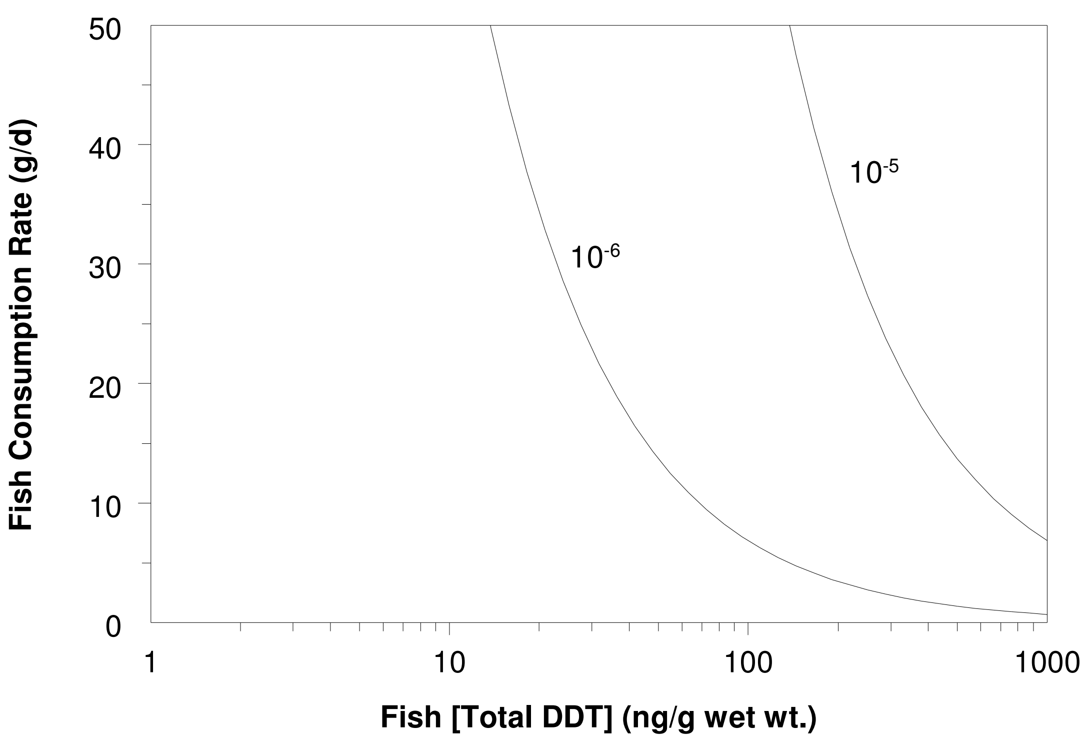
2. Health Risk Calculations for Variable Consumption Rates

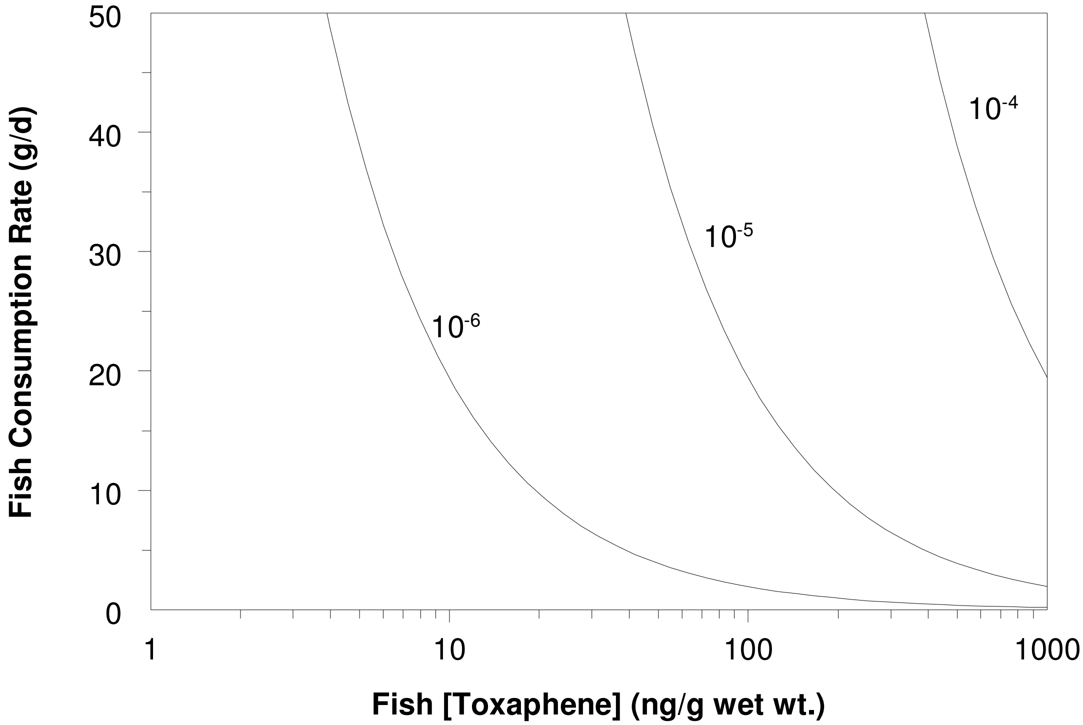
J. Shine

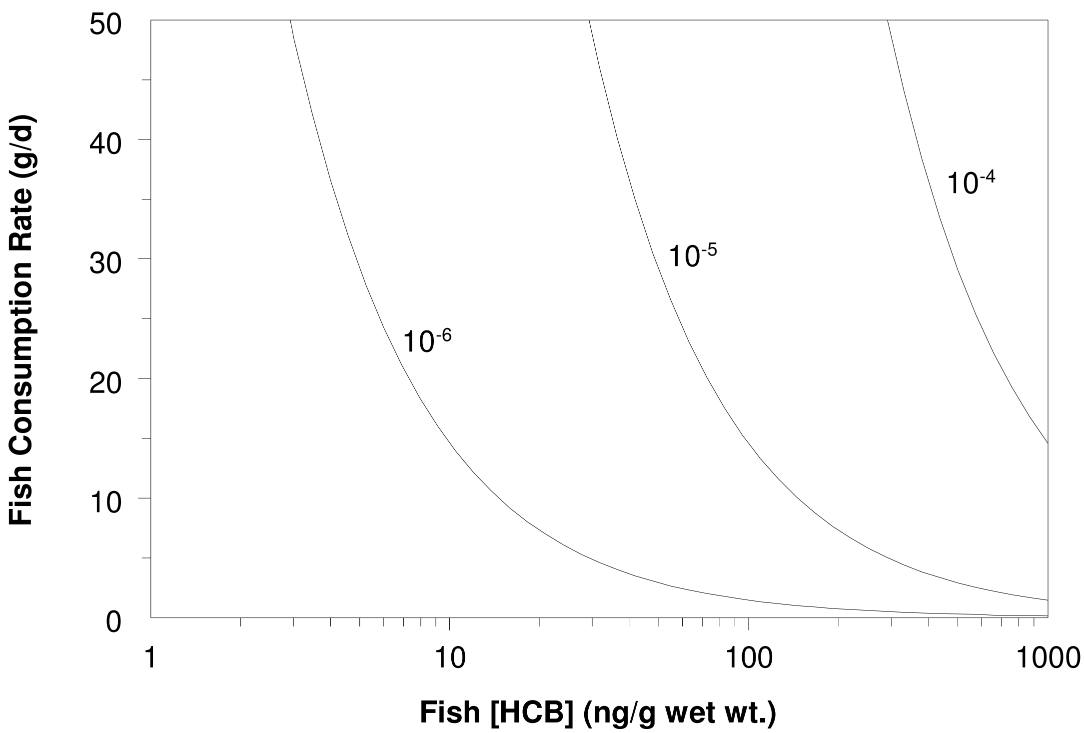
Exposure Assumptions (per Ben/OEHHA):

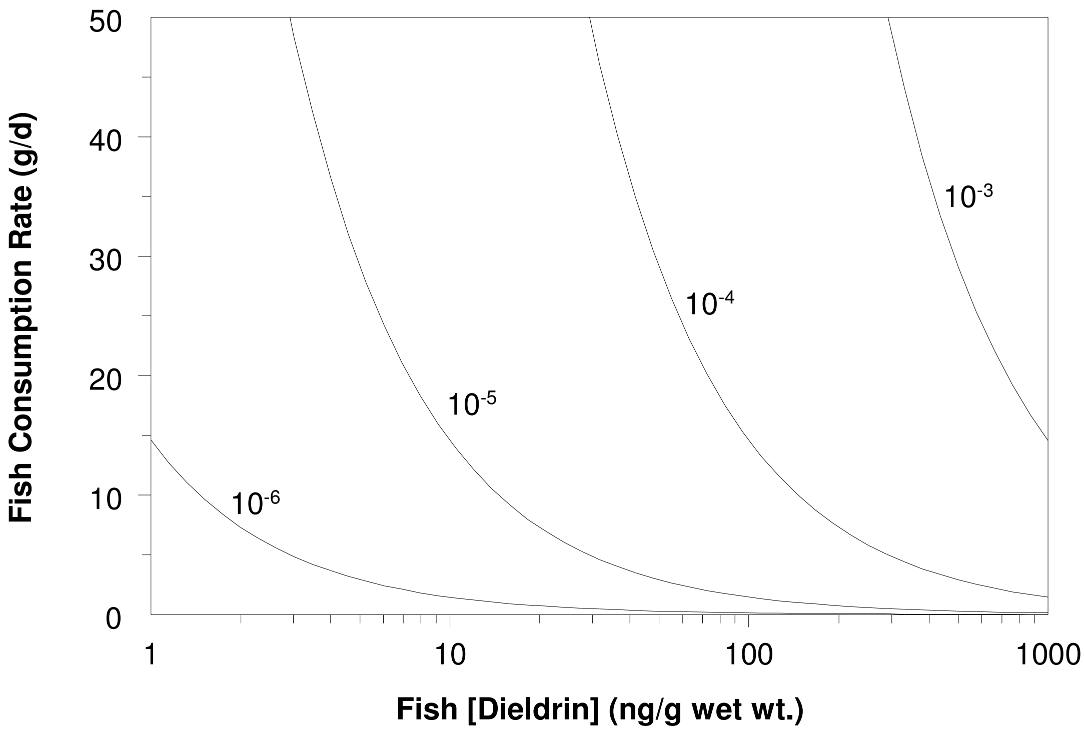
1) Exposure Duration: 30 years
2) Averaging Time: 70 years
3) Body Weight: 70 kg
4) Cooking Loss: 0.7 (unitless)
5) Cancer Slope Factors (units = $(mg/kg/d)^{-1}$)
    - Sum Chlordanes: 0.13
    - Dieldrin: 16
    - HCB: 1.6
    - Toxaphene: 1.2
    - Sum DDTs: 0.34
    - Sum PCBs: 2
6) Reference Doses (units = mg/kg/day)
    - Sum Chlordanes: 3.3E-5
    - Dieldrin: 5E-5
    - HCB: 8E-4
    - Toxaphene: 3.5E-4
    - Sum DDTs: 5E-4
    - Sum PCBs: 2E-5

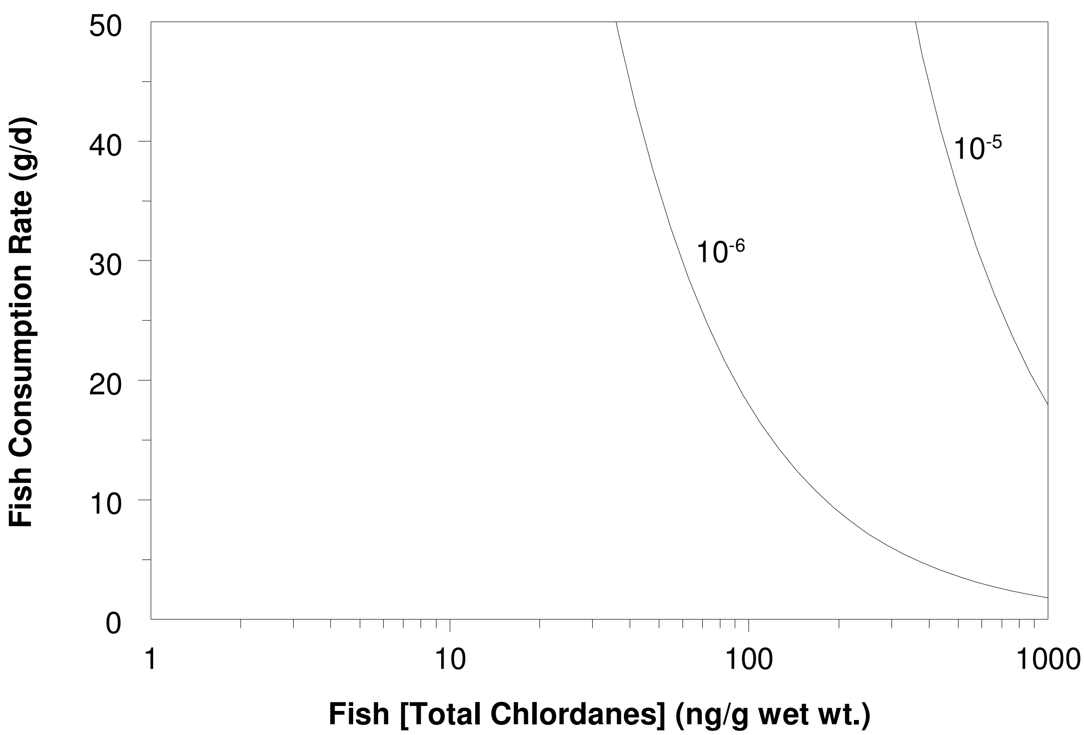

50
40
30
20
10
0
1
10
100
1000
Fish Consumption Rate (g/d)
Fish [Total PCB] (ng/g wet wt.)
10-4
10-5
10-6

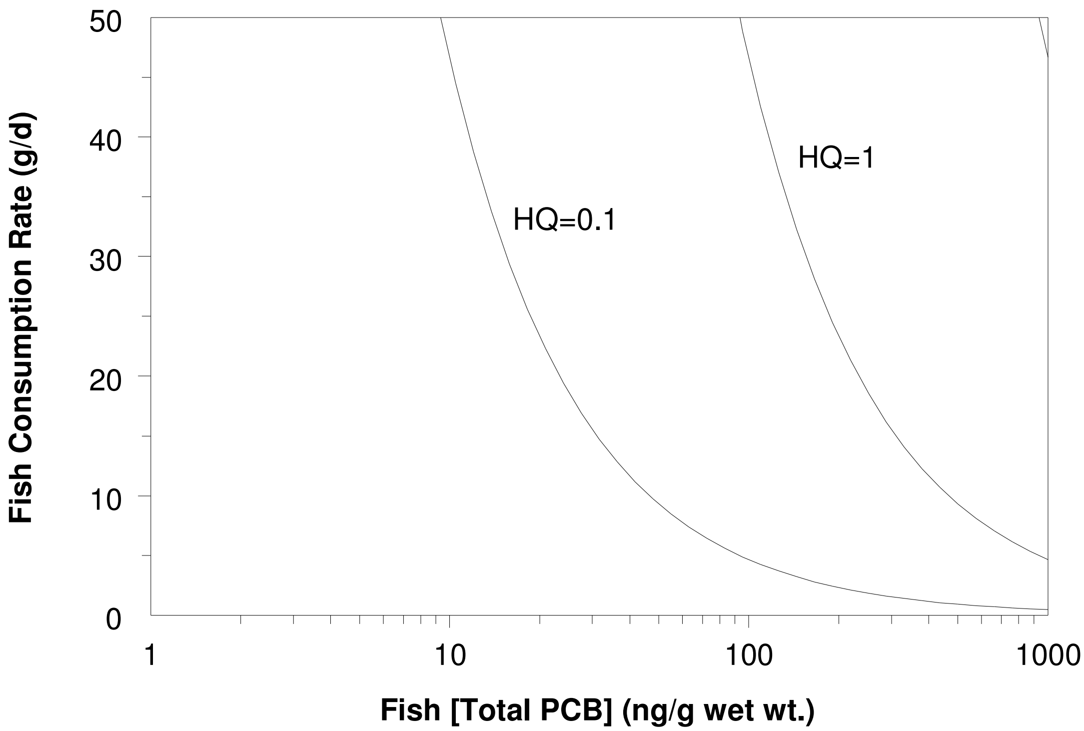

50
40
30
20
10
0
1
10
100
1000
Fish Consumption Rate (g/d)
Fish [Total DDT] (ng/g wet wt.)
10-5
10-6

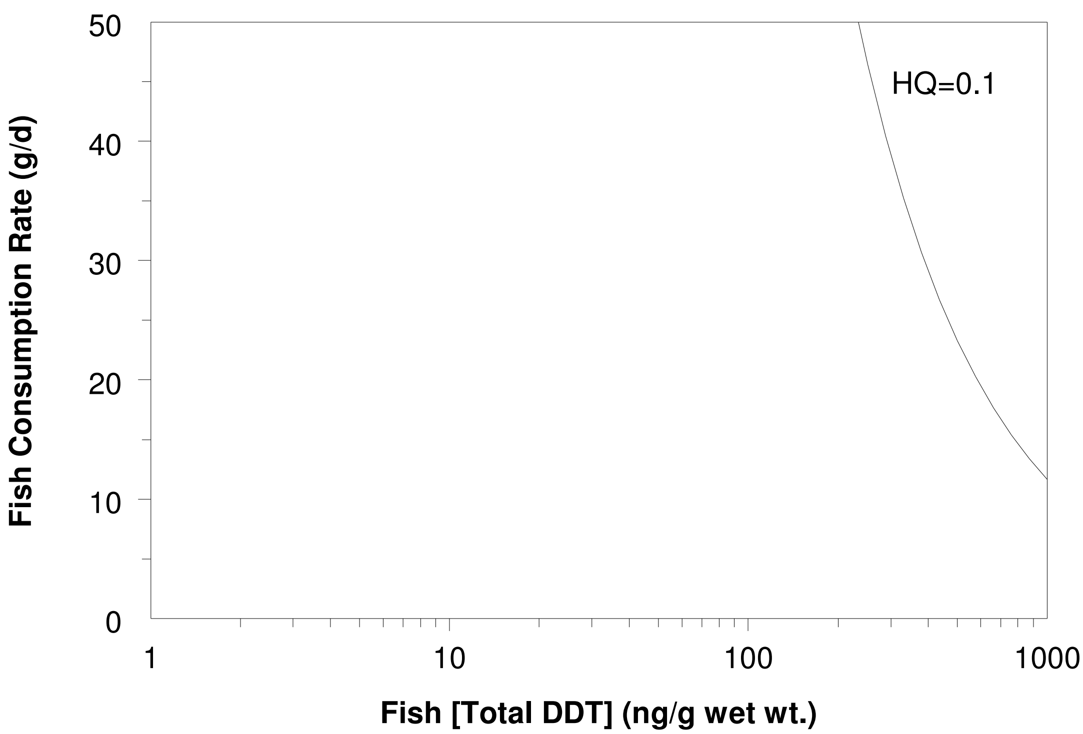

50
40
30
20
10
0
1
10
100
1000
Fish Consumption Rate (g/d)
Fish [Toxaphene] (ng/g wet wt.)
10^{-6}
10^{-5}
10^{-4}

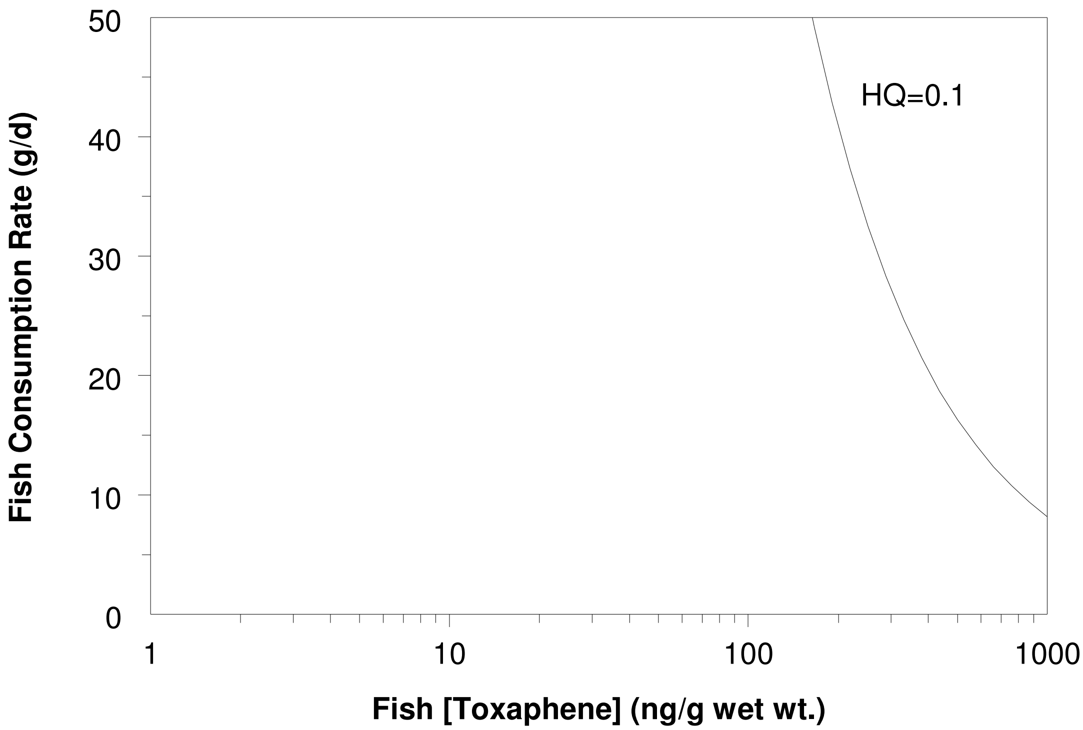

50
40
30
20
10
0
1
10
100
1000
Fish Consumption Rate (g/d)
Fish [HCB] (ng/g wet wt.)
10^{-6}
10^{-5}
10^{-4}


50
40
30
20
10
0
1
10
100
1000
Fish Consumption Rate (g/d)
Fish [Dieldrin] (ng/g wet wt.)
10-3
10-4
10-5
10-6

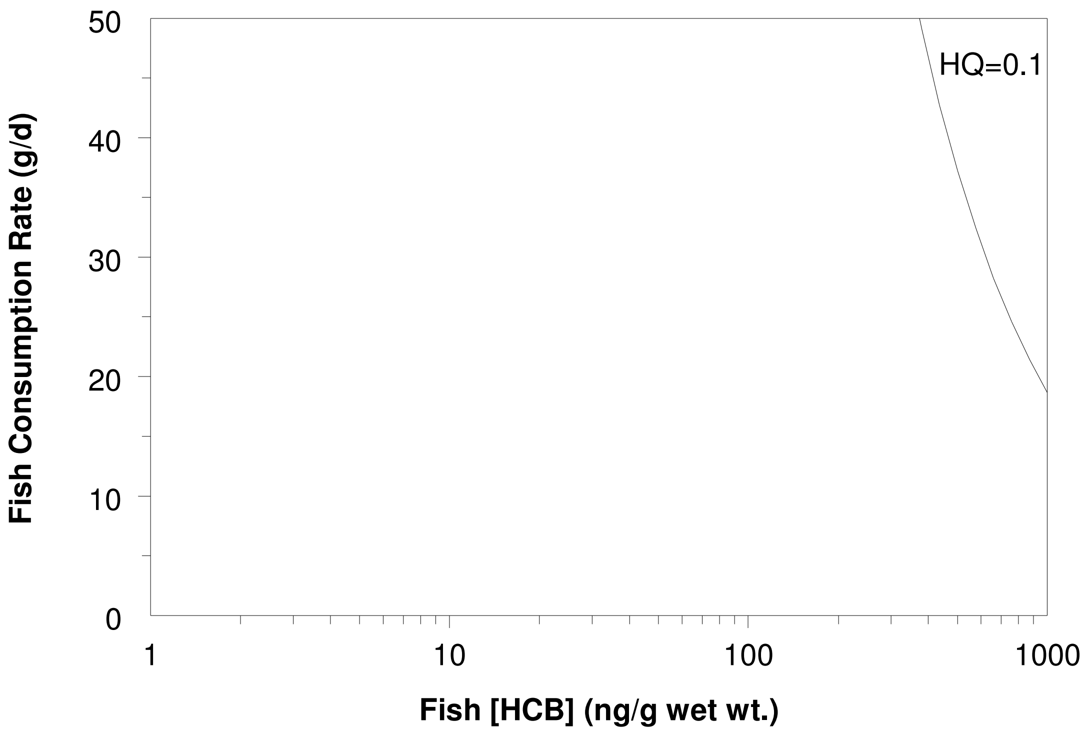

50
40
30
20
10
0
1
10
100
1000
Fish Consumption Rate (g/d)
Fish [Total Chlordanes] (ng/g wet wt.)
10-5
10-6


Fish Consumption Rate (g/d)
50
40
30
20
10
0
1
10
100
1000
Fish [Total PCB] (ng/g wet wt.)
HQ=0.1
HQ=1

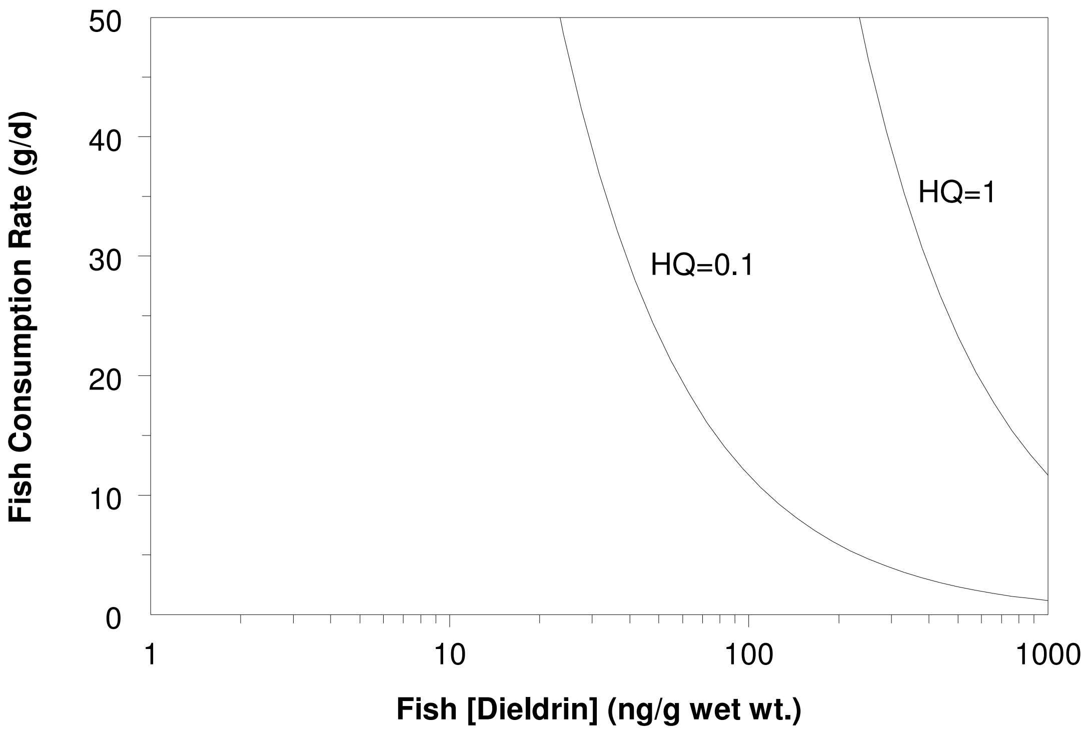

Fish Consumption Rate (g/d)
50
40
30
20
10
0
1
10
100
1000
Fish [Total DDT] (ng/g wet wt.)
HQ=0.1



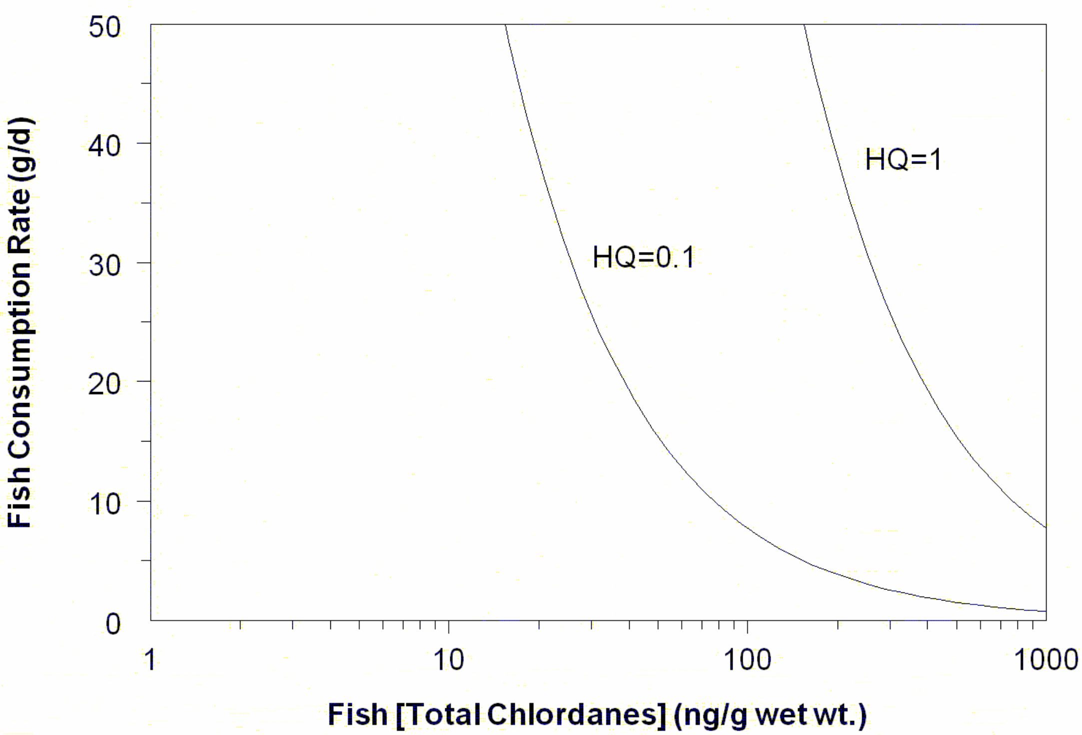
50
40
30
20
10
0
1
10
100
1000
HQ=0.1
Fish Consumption Rate (g/d)
Fish [Toxaphene] (ng/g wet wt.)



50
40
30
20
10
0
1
10
100
1000
HQ=0.1
Fish Consumption Rate (g/d)
Fish [HCB] (ng/g wet wt.)



50
40
30
20
10
0
1
10
100
1000
Fish Consumption Rate (g/d)
Fish [Dieldrin] (ng/g wet wt.)
HQ=1
HQ=0.1



50
40
30
20
10
0
1
10
100
1000
Fish Consumption Rate (g/d)
Fish [Total Chlordanes] (ng/g wet wt.)
HQ=1
HQ=0.1