EMAIL REGARDING U S EPA REGION IV COMMENTS ON FISH CONSUMPTION RISK FOR THIRD BATTALION POND AT SITE 3 CAUSEWAY LANDFILL MCRD PARRIS ISLAND SC

4/16/2009

U S EPA REGION IV

-----"Harrington CIV Timothy J" <timothy.j.harrington@usmc.mil> wrote:

To: Lila Llamas/R4/USEPA/US@EPA
From: "Harrington CIV Timothy J"
<timothy.j.harrington@usmc.mil>
Date: 04/16/2009 08:04AM
Subject: RE: FW: EPA Withdrawal of TCE Guidance

Lila,

Here are some preliminary thoughts from our Natural Resources Manager. As he indicates, his thoughts are based primarily on professional judgment rather than any scientific analysis.

1) & 2) edible fish by Asian population & fishing rules - Everything Is edible - from small baitfish (menhaden, mullet, spot, croaker, etc...everything) to gamefish. There are no regs pertaining to quantity and size limits for non-gamefish. Recreational fisherman, if abiding by gamelaws, are allowed to keep gamefish:

A. 3 red drum/person/day between 15 to 23 inches total length
B. 10 spotted seatrout/person/day - 14 inches total length or bigger
C. 20 flounder/person/day - 14 inches total length or bigger
D. 5 black drum/person/day between 14 to 27 inches total length
E. 20 sheepshead/person/day, no size limit
F. 10 weakfish (summer trout)/person/day - 12 inches total length or bigger

3) & 5) fish leaving the pond & transfer of fish - Why would they want to leave? They have all the necessary ingredients for survival, except (in some cases) spawning habitat (i.e. deeper water). This is what I'm thinking (anecdotally, no scientific fishery sampling) is what's going on with the flounder during the fall/winter months. They are hardwired to spawn in deeper river water and may be trying to exit the pond during these months with extremely high moon tides (greater than 8') when the water is flowing into the pond from Ribbon Creek. A bonus for them is the abundance of baitfish and other prey items that enters with the water flow, therefore a large number of them have been deftly angled by the wily fisherman dunking anything that resembles a tasty morsel in front of the pipes (where the docks are located). The red drum spawn about the same time, but they (wild fish) usually enter the tidal rivers from the ocean and the sounds to deposit there genetic material in the overly productive nutritious soup we call the estuary. So the population in the pond are really screwed up, as they lack that part of their lifecycle in the offshore open ocean, we think. I guess they could get out, go do what they do and then come back before Mom & Dad find out. The wild fish typically spend the first five years or so in the same general estuarine area from whence they were conceived and then "migrate" gradually to the deeper rivers, sounds and finally cean. Black drum and their life history are similar to red drum except that their spawning time is spring (now). I believe they would have a difficult time leaving (and possibly entering) due to their size, the size of the pipes and design of the weir on the creek side. Again without actual fishery investigations, tagging and tracking, this is only educated conjecture. Smaller individuals could enter as with the baitfish, shrimp and crabs and simply avoid being eaten until they are large enough to be the eater. Some of the fisherman will release large

red drum and black drum by carrying them over to the creek side and letting them go into the creek. Baitfish on the other hand, I believe could and do, more easily enter and leave the pond.....as evidenced by the catches the castnetters reveal during their sessions.

4) entering the pond from elsewhere - There's always the widely Popular belief that some eggs and fry could be transported by wading birds, turtles, mink, otter, etc. that travel to and fro the marsh and creeks and the pond, or - and don't laugh - the rain and windstorms. There is always the possibility somebody could be bringing outside fish and dumping in the pond. Years ago (late 80's & 1990's) when I worked for SCDNR, we stocked millions of week old red drum fry in the pond.

Tim

-----Original Message-----
From: Llamas.Lila@epamail.epa.gov [mailto:Llamas.Lila@epamail.epa.gov]
Sent: Thursday, April 16, 2009 16:03
To: Harrington CIV Timothy J
Subject: RE: FW: EPA Withdrawal of TCE Guidance
Importance: High

Thanks Tim!! I completely respect and understand "professional judgement". A LOT of what we do is that rather than reliance on pure scientific data. We tend to gather just enough data to use our professional judgement to make decisions. And that is reasonable. We can't study each issue to death... or at least, not any other than Site 45 : -)

Is this natural resource manager Ron Kinlaw? Or someone else? if so, do we need them on the conference call and/or at the meeting as well?

I see the taking limits you listed for game fish, but is there not also some rules about taking by Rod'n'Reel-only from the pond?

Is there any current-day/or more-recent stocking of the pond, as you did in the 80s and 90s?

If the fish are not spawning, and there is no stocking, do the populations in the pond appear to be maintaining simply by the arrival of new fish via the tides?

You mention the great success of the anglers and casters in the pipe area while water is entering... Does anyone ever fish the other side of the pipe as tides are dropping? Are there docks on that side? Just trying to get an idea of whether there has been any kind of observation of fish leaving the ponds. Or do we not notice it simply because the dock is not over there so people only fish the incoming tide pond side?

Also, you mention the limitations on size entering and leaving due to the weir hieght, design, etc. At an extremely high full moon tide (8'), what is the largest fish you think could enter the pond? the largest you think could exit the pond?

You question why they would want to leave, since they have everything,

except spawning grounds.... Are there any types of fish in the pond that would simply typically follow the tidal stream flow, as opposed to only leaving to spawn?

That's all I can think of..... for now... : -)

Lila

Email From John Holloway – 4/17/09

Lila,

Regarding the questions (below) about the site 3 pond/impoundment area you emailed Tim:

I (John Holloway) am the Nat. Res. Manager; I'll leave it to Tim to make the call about including me in the meetings and conference calls.

Our Depot Order for fishing references the State laws, however gamefish may not be kept if captured with castnets and the individual must have a valid SC fishing license in order to keep any non-gamefish captured in a castnet.

The pond has not been stocked subsequent to when SCDNR supplied the red drum fry back in the late 80's and 1990's, that I know of.

The fish may be spawning, but without fishery sampling, we don't really know. By fish, we need to clarify what we are discussing. Wild gamefish species such as red drum, flounder, trout, black drum typically spawn in deeper river/creek habitats and the resulting fry "grow up" in the estuary (the creek/river/marsh/sound interface), thus we could be getting natural recruitment during high tides above ~8 feet into the pond (this is the way impoundments work). The populations of gamefish we have in the pond now are very large and of spawning age, so I'm not sure if they are spawning and producing viable offspring. They may have adapted to the conditions and are spawning (because this is such a strong instinct) but maybe the eggs/fry are flowing out, since the deepest water in the pond is near the pipes. We don't hear of too many, if any, small or juvenile gamefish being caught, other than "poptart" flounder (meaning one could cook them in a toaster 'cause they are so small) in cast nets. Could be that small ones are being preyed upon, leaving or just can't survive. Non-gamefish (e.g. baitfish, spots, croakers, mullet, etc.) are edible and are harvested to either eat or to use for bait for gamefish. They do enter with the water flow through the pipes. Wild non-gamefish have similar requirements for habitat and spawning times as with the gamefish. The only difference being size. Anecdotally speaking, I believe the flounder population has declined and this may be due to fishing pressure. So there may not be the reproductive success occurring in the pond or through natural recruitment to keep up with this pressure. The red drum are still

relatively plentiful, but these large specimens (outside the legal "keeper" size limit) have to be released, so they may be recaptured over and over again.

There are no docks on the creek side, very few people fish that side as it is not as productive. So there, of course, are not the "eyes" on that side to observe anything leaving. But just looking at the design of the weir leads me to believe not much large stuff can get in or out. The larger specimens tend to dwell near the bottom and probably shy away from all the noise emanating from the docks, the people and the water flow.

Most high moon tides are greater than 8 feet, some are 9 feet and even 10 feet has been observed when the wind is right (NW) and all the planets, the sun and the moon line up just right. As far as the size of fish that could enter or exit the pond, that's hard to determine with out doing some sampling. I do know that we have had instances of river otters entering and a loggerhead turtle entering, so it's possible size wise, but whether fish of that size will enter or exit on purpose, I believe, is rare. Red drum and black drum of the trophy size in the pond now, would not even enter the small creeks that feed the pond. They typically inhabit deeper rivers and sounds.

Again, smaller baitfish and non-gamefish would be the more likely candidates to leave the pond via the outwelling currents through the pipes.

If I knew more about what you're after WRT to tissue sampling and what you're trying to determine, maybe I could help with that.

Hope all this helps, let me know if you need anything further.

V/R John

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Phone call with John Halloway 4-24-09

I explained in more detail what I was trying to do with my questions, which was to learn as much as possible about the pond conditions and fish, etc so as to minimize uncertainty. After a long conversation, John reached the same conclusion as I had a long time ago. Due to the connectivity of the pond, it will be very difficult to minimize uncertainty. Highpoints of the conversation included:

The otter DID NOT crawl over the wier. He came through so fast he must have bounced off the wier and pipes so much that he was totally disoriented when he came out by the pier. Observers pulled him up in a net and let him recover his senses before he slipped back in the water.

The sea turtle that came through was fairly large. 2-3 feet wide and at least 50 pounds. It took a couple or three gentlemen to pick it up.

Therefore, the pipes not only let through large creatures at high tide, but also likely suck up whatever is nearby and forces it through.

John now understands that fish sampled need to be 8 years or younger.

John suggested that red drum remain in the creek until they mature. So not likely to enter pond as a young fish. John stated that Red Drum mature in the creek at 5-7 years for females, and at 3-4 years for males. Therefore, males would have more of a chance of entering the pond and being exposed for up to 4-5 years within the pond.

John suggested that flounder are more likely to enter the pond at a larger size. However, flounder would be sediment dwelling fish, and therefore conservative, maybe.

John suggested that mullet are likely to enter the pond at an earlier age (but may also come and go through the very early years? NOTE: Ask John again). Mullet feed on lower trophic organisms, therefore picking up more from the sediments, perhaps. Therefore, a conservative choice. NOTE: Would this be a small range fish in a localized area with high concentrations for a spatial indicator? = Ask John)
NOTE: We still need foraging and home range info for at least flounder, mullet, red drum.

United States
Environmental Protection
Agency

Office of Marine and
Estuarine Protection (WH-556F)
Washington, DC 20460

Office of Water Regulations
and Standards (WH-552)
Washington, DC 20460

Water | September 1989 | EPA-503/8-89-002

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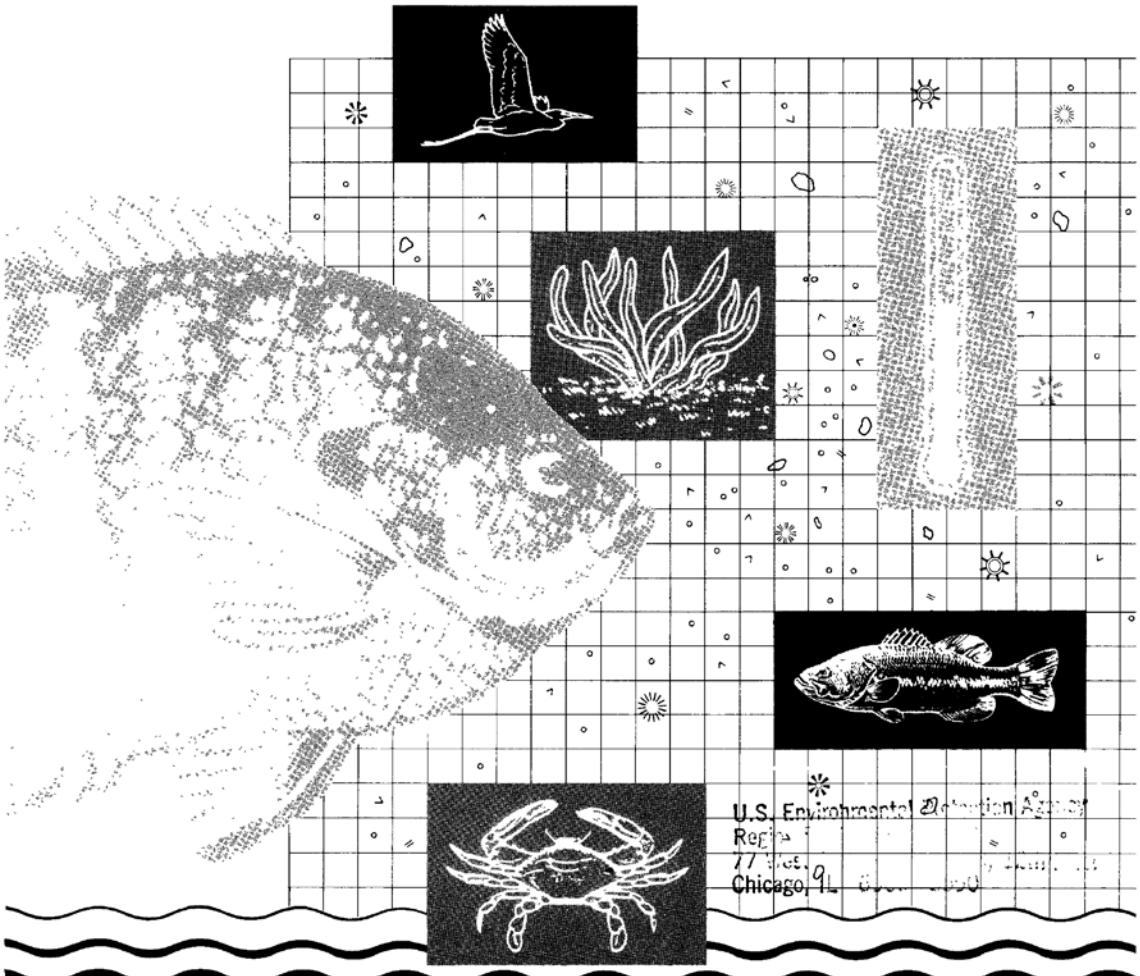
Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish:

A Guidance Manual



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Exposure Assessment

The elements of a study design for analysis of chemical residues in tissue include:

- Objectives
- Target species and size (age) class
- Sampling station locations
- Target contaminants

- Sampling times
- Kind of sample (e.g., composite vs. grab, cooked vs. raw; fillet vs. whole organism)
- Sample replication strategy
- Analytical protocols, including detection limits
- Statistical treatment of data.

Because the complexity and specific features of a sampling design will depend on the objectives of the exposure assessment, no single design can be recommended here. Nevertheless, some basic steps in the study design process can be summarized as follows:

- Define concise objectives of the study and any hypotheses to be tested.
- Define spatial and temporal characteristics of fisheries relative to harvesting activities (e.g., seasonality, catch or consumption rates, species composition, size ranges, demersal vs. pelagic species).
- Define harvesting activities and methods of preparing food for consumption that potentially affect exposure to contaminants.
- Define kinds of samples to be collected (species, type of tissue, mode of preparation) and variables to be measured, based on a preliminary exposure analysis.
- Evaluate alternative statistical models for testing hypotheses about spatial and temporal changes in measured variables. Select an appropriate model.
- When possible, use stratified random sampling for each fish and shellfish species, where the different strata represent different habitat types or kinds of harvest areas that may influence the degree of tissue contamination.
- When practical, specify equal numbers of randomly allocated samples for each stratum/treatment combination (e.g., habitat type in combination with species or season).
- Include samples from a relatively uncontaminated reference or control area to help define local contamination problems.
- Perform preliminary sampling or analyze available data to evaluate the adequacy of alternative sampling strategies (e.g., composite samples vs. tissue from individual organisms) and statistical power as a function of the number of replicate samples.
- Develop a QA/QC program that covers: sample collection and handling; chain of custody; data quality specifications; analytical methods and detection limits; data coding; data QA/QC steps to assess precision, accuracy, and completeness; database management specifications; data reporting requirements; and performance audits.
- Define data analysis steps, including statistical tests, data plots, summary tables, and uncertainty analysis.

Example Objectives:

Example 1:

- **Exposure Assessment:** Estimate the worst-case exposure for a wide range of contaminants over a predefined geographical area.
- **Bioaccumulation Design:** Estimate mean concentrations of contaminants in edible tissues of a selected narrow size range of individuals of the most contaminated species during the season of peak contaminant concentrations.

Example 1 represents a screening survey to evaluate the need for further work. Edible portions of a limited number (e.g., 3-5) of individual organisms or composite samples would be analyzed for a large number of compounds and the risk assessment conducted assuming moderate or high (but plausible) consumption rates. The species and size range selected would be the ones most likely to accumulate high concentrations of contaminants. Typically, the target species for a screening survey would be the largest individuals of a bottom dwelling species associated with soft sediments.

Example 2:

- **Exposure Assessment:** Estimate the long-term average exposure to each of the contaminants A, B, and C through consumption of aquatic species L, M, N, and O combined from harvest area Z for the average person in the exposed human population.
- **Bioaccumulation Design:** Estimate the mean concentrations of contaminants A, B, and C in edible tissues of aquatic species L, M, N, and O combined from harvest area Z over an annual period.

Example 2 illustrates a simple case involving the consumption of multiple species from a single harvest location. Individual or composite samples of each species would be analyzed separately during different seasons or during a single season expected to represent the annual average. If samples are analyzed separately during different seasons (e.g., see discussion of Example 4 below), the mean annual exposure for all species could still be calculated from the seasonal data. In general, highly composited samples are not recommended because information on different factors (e.g., species, seasons) that affect contaminant concentrations is lost.

Example 3:

- **Exposure Assessment:** Estimate a plausible-upper-limit of exposure to each of the contaminants A, B, and C through consumption of aquatic species L, M, N, and O combined from harvest area Z for a seasonal harvester in the exposed population.
- **Bioaccumulation Design:** Estimate the upper bound of the 95 percent confidence interval of the mean concentration for each of the contaminants A, B, and C in edible tissues of aquatic species L, M, N, and O combined from harvest area Z during the season of highest contamination.

The general sampling design for the objectives of Example 3 would require replicate composite samples to estimate upper bounds of 95 percent confidence intervals for the mean concentrations of contaminants across species. To meet these objectives, samples could be composited across species, although this is generally not recommended. Multispecies composites would not provide data for assessing exposures corresponding to different dietary habits. To obtain an upper-limit estimate of exposure, it might be sufficient to analyze samples from only one season if available information on seasonal variation was sufficient to select one season as the expected worst case.

Example 4:

- **Exposure Assessment:** Estimate the probability distribution of exposure to each of the contaminants A, B, and C through consumption of each of aquatic species L, M, N, and O from harvest area Z for various segments of an exposed population (e.g., ethnic groups) over an annual period.
- **Bioaccumulation Design:** Estimate the probability distribution of concentrations of contaminants A, B, and C in edible tissues of each of aquatic species L, M, N, and O from harvest area Z over an annual period.

To accomplish the objectives of Example 4, extensive seasonal data on the dietary composition of several subgroups of the exposed population must be available. Separate replicate composite samples of each harvested species could be analyzed for each season. During each season, the species analyzed would correspond to those represented to a significant extent in the diet. Probability (frequency) distributions and means of contaminant concentrations would be derived for each species during each season. By combining data from different species, the probability distribution of exposure and the mean exposure weighted by species representation in the diet could be calculated for each population segment. Note that data to support the analyses required by Example 4 are seldom available before a specially designed study is conducted.

Example 5:

- **Exposure Assessment:** Estimate an average and a plausible-upper-limit of exposure to each of the contaminants A, B, and C through consumption of each of aquatic species L, M, N, and O from each of the harvest areas X, Y, and Z over an annual period.
- **Bioaccumulation Design:** Estimate the mean concentration and the upper bound of the 95 percent confidence interval of the mean concentration for each of the contaminants A, B, and C in edible tissues of each of species L, M, N, and O from each of the harvest areas X, Y, and Z during each of the harvest seasons.

The sampling strategy appropriate for Example 5 is complicated by the occurrence of discrete harvest areas. Replicate composite samples of a given species would generally be required for each season and area in which the species is harvested. Because the characteristics of the exposed population may differ among harvest areas, it may be appropriate to divide the exposed population into segments corresponding to geographic areas, ethnic groups, age classes or other factors. The seasonal and total annual exposure for each segment of the exposed population would be calculated for each species as in Example 4 above.

SELECTING A TARGETED SPECIES:

Ideally, the set of species selected for contaminant analysis would include all harvested species. Because available data and funds for collecting new data are often limited, only one or a few target species may be used for human health risk assessment. The particular species selected for an exposure assessment will depend on the study objectives. Examples of approaches and guidance on selection of target species are given below.

Four alternative objectives that affect the choice of target species are:

- Perform a comprehensive analysis of harvested species
- Characterize the typical exposure case represented by the dominant harvested species
- Characterize exposure for the worst-case species (e.g., heavily consumed species expected to be highly contaminated)
- Characterize the spatial distribution of contamination using an indicator species.

The criteria for selecting species for chemical analyses to meet each of these objectives are shown in Table 4. For the first objective (comprehensive species analysis), all of the harvested species do not necessarily need to be analyzed, but some criterion is required to select species for analysis (e.g., the most important species in the harvest that together comprise greater than 95 percent of the catch by weight). For the second objective (typical exposure), a few of the dominant species (by

weight) in the harvest may be selected to represent a typical exposure level. However, this approach has the major disadvantage that highly contaminated species may be overlooked (see **Dominant Harvested Species** below). For the third objective (worst-case species analysis), the target species should be among the most contaminated species in the harvest. If the worst-case assessment is species-specific (i.e., the consumption rate for a single species is used to estimate exposure), then the target species should also be one of the dominant species in the harvest. When the dominant component of the diet differs among subpopulations of concern, then specific dietary information for subpopulations should be used to select the worst-case target species. The target species may be the most contaminated species regardless of its status in the diet of the entire exposed population. For the last objective (site-specific analyses of the spatial distribution of contamination), an indicator species with a small home range that is expected to have high concentrations of contaminants in edible tissue would be selected. Note that an indicator species could be a species that is relatively rare in the harvest. Although home range size and degree of contamination of species may not constrain the selection of species to meet the first two objectives listed above, selecting species without regard to contamination levels will not necessarily ensure that the overall purpose of performing an exposure assessment will be met.

TABLE 4. Criteria for Selecting Target Species[a]

	Alternative Design Objectives[b]			
Species Characteristics	Comprehensive Species Analysis	Typical Exposure Case	Worst-Case Species	Spatial Pattern Indicator Species
Harvest ranking	**Species forming 95% of catch**	**Dominant species in catch**	**Dominant species in catch**	Variable
Home range size	Variable	Variable	Variable	**Small**
Contamination level	Variable	Variable	**High**	**High**

SEE MORE DETAILS ON SELECTING TARGET SPECIES FOR EACH APPROACH

From EPA's perspective, the Fish Tissue Sampling and Analysis Plan (SAP) will likely need to have two objectives. In a simplified form they might be,

1) Determine the concentration of Site 3 related COCs, as contributed by Site 3 Post-remedy, in fish tissue being consumed by pond fisher persons, in order to make remedial decisions pertaining to Site 3;

And,

2) Determine the concentration of any contaminants currently, regardless of where they came from, in fish tissue being consumed by Site 3 pond fisher persons, in order to communicate overall risk.

The second is definitely the easiest, and for that reason is not addressed here, except that some of the same thoughts apply, but not nearly as many, and not really as important to the outcome.

To meet the first objective, determining risk as it relates to Site 3 contaminants, we need to:

1) Find out as much as we can about things we need to know to minimize uncertainties associated with the fish tissue sampling and risk assessment, as it pertains to Site 3 related COCs.

Background: We have the interview results. We have the National Fish Advisory Guidance. We know where the area of contamination is. We know there are fishing restrictions in the pond. Outside of that, I have also spent some time discussing Site 3 Pond Conditions with Tim Harrington, John Holloway, Ron Kinlaw, and Heber Pittman. It becomes apparent that we need to try to find out how much is known versus assumed versus not known about pond conditions and fish behaviors. For instance we **Know** the weir height = 7 feet (I think - although some have indicated it needs to be verified.), we **Know** the height of tides (up to 10 feet at most - apparently). We **Know** fish enter from the creek side at high tides. We are **assuming** it is mostly smaller fish, however, fish as large as a sea turtle (2-3 feet wide, about 50+ lbs) can enter at the highest tides, and once a large otter came barreling through the pipes at high tide and was totally disoriented from the force of the trip through the pipes. So more likely, if fish of any size get near the pipes, they are sucked in. We **do not know** much about which fish leave the pond, although we are **assuming** only the smaller fish might come and go, but who really knows. We **do not know** exactly where the fish spend their time in the pond, but we can estimate with species-specific foraging and home ranges. We **need to know** foraging and home ranges for each species sampled. Etc., etc., etc.

So, broad based categories of things we need to make statements about in the SAP, because they impact uncertainty in the study, might look something like:

Pond Conditions	(connectivity from pond to creek and back, weir height, pipe volume, etc.)
Tide Conditions	(tide heights passing the weir, frequency, duration, etc.)
Fish Behaviors	(By species - likelihood to follow tides, spawning, foraging and home ranges, level at which they feed = bottom, mid, surface, etc.)
Fishing Behaviors	(net.vs.RnR, obeying limits = RnR only / # / size?)
Fishing Restrictions	(See John H. below, do these get applied? In the SAP? risk calc's?)
Consumption Behaviors	(see interview results, fillet .vs. whole fish, see Guidance on Subsistence Fishers for rates and Screening Levels, etc.)

NOTES FROM JOHN HOLLOWAY, MCRD Nat. Res. Mgr.: There are no regs pertaining to quantity and size limits for non-gamefish. Depot Order for fishing references State laws, however gamefish may not be kept if taken from cast nets and the individual must have a valid SC fishing license in order to keep any non-gamefish captured in a cast net. Recreational fishermen, if abiding by game laws, are allowed to keep gamefish:

A. 3 red drum/person/day between 15 to 23 inches total length
B. 10 spotted seatrout/person/day - 14 inches total length or bigger
C. 20 flounder/person/day - 14 inches total length or bigger
D. 5 black drum/person/day between 14 to 27 inches total length
E. 20 sheepshead/person/day, no size limit
F. 10 weakfish (summer trout)/person/day - 12 inches total length or bigger

2) After finding out all we can, determine the uncertainties which remain, as associated with the forthcoming fish tissue sampling event with respect to pond conditions / fish, given what little we know (see above).

e.g. How do we know if the individual fish we sample has been exposed to Site 3 contaminants its entire life? (i.e. it was spawned within site boundaries and has a feeding range which lies solely within Site 3 Boundaries (which is only a very limited area of sediment, so this scenario is highly unlikely to exist)) or has it entered the pond at some time after birth? If so, when did it enter? Has it stayed the whole time since or can it come and go? Would it come and go even if it could?

From what I've gathered, a list of uncertainties related to pond conditions / fish might look a little like this:

Age/size at entry to pond and/or date of entry
Age/size at which the fish can / will no longer leave the pond
Foraging range boundary location (i.e. center point for range)

3) After finding out all we can, determine the uncertainties which remain pertaining to the fishing habits and actual takings of the subsistence fishers (assuming we know the average behaviors of recreational fishers.)

From what we've gathered, a list of uncertainties related to fishing habits and actual takings might look a little like this:

Ratio of species/amounts to each other
Amount of fish caught with net versus Rod-n-Reel
Amount of limited species fish kept, even though restricted to Rod-N-Reel/#/size.
(After hours, when no one is looking, etc...)
Consumed as filet or whole

4) After identifying uncertainties, design the sampling plan to reflect post-remedy exposure, and to minimize uncertainties to the degree possible, while reflecting representative fish takings to the degree possible.

Fish must be 8 - 9 years old or less to represent Post Remedy exposure and uptake of chemicals.

Pick an approach and justify why:
Spatial Indicator Species .vs. Comprehensive Analysis .vs. Dominant Harvested (Typical) .vs. Worst Case

Spatial Indicator = species with very small home range and expected to have high concentration.
Comprehensive = most, not all, species sampled which comprise >95% of catch by weight
Typical = sample a few species which comprise >50% of catch by weight.
Worst-Case = target the most contaminated species in harvest (e.g. flounder, mullet, etc?)

If Comprehensive:
Fish types should be reflective of those typically taken.

(Do we include shrimp, crab (stone and blue), squid, even though these are not as likely to accumulate much? How do we account for that consumption if not sampled?)

Fish taken included flounder, spots, redfish, pin fish, mullet, sheep head, black drum, croakers ….(as well as the critters above).

(Here we must decide if we include Rod-N-Reel-only fish or not, or do we assume occasional Rod-N-Reel fishing or breach of restrictions. Do we assume size limits are followed?)

Do we limit fish to a certain minimum size in order to reduce the likelihood that this fish just came to the pond last month at spring high tide, etc? (See J.H's notes)

Do we include those small fish even though they may have just gotten there, because the actual takings include them? How do we account for that consumption if not sampled?

Each fish collected should be measured and recorded to determine size/age.
Fish should be analyzed by species, to allow for a variety of consumption scenarios, if needed.
Fish should be processed according to consumption habits by species/size (fillet .vs. whole fish).

How do we set location of samples? Near the dock to reflect fishing habits? Near the contaminated sediments to get worse case scenarios? Stratified random sampling for each species where the different strata represent different habitats (i.e. near doc, near contaminated sediments, in far end of pond for background) using VSP? Taking "Background" samples too, to i.d. local effects?

Keep number of samples the same between species, to eliminate difficulties associated with statistical analysis.
When should samples be taken? At incoming tides when fishers like to fish? (Ask John if this is the case?) At low tide, or at half tide - when conditions may be more stable? Does it matter?
Composite .vs. grab? (Limit 5 fish per composite) Cooked .vs. raw?

5) Given the Knowns and Uncertainties in 1, 2, and 3 above, and the results from the sampling, determine the contribution of Site 3 related contaminants to fish tissue concentrations and calculate associated risks. NOTE: We really need to talk this through and get consensus on how this will be done and what it tells us in the end (i.e. what it helps us decide regarding the remedy.)

Define the decision rules.

Do we screen against background? Is background the other side of the pond or somewhere out in the creek? Or both?

Determine availability of COCs outside of the Site 3 area. (if some, then likely part is Site 3 related, and part is not...if none, then all is likely Site 3 related regardless of time spent within Site 3 boundaries.) In current post-Remedy sediment COCs, all have an outside source: Copper coated jackets on lead bullets in creek; DDT and Mercury are both widespread.

Determine percent time spent within Site 3 contaminated sediment areas, from estimated date of entry and range information above.

Use % time spent in Site 3 to determine % of tissue concentration contributable to Site 3. Calculate risk.

Use % of tissue concentration not contributed by Site 3 to determine if risk is already unacceptable based on widespread sources.

Compare these findings with the overall risk calculated on all contaminants found in tissue (regardless of relation to Site 3 and/or time of entry.) What does this tell us? Anything?

To do all this, we must agree on how the risk will be calculated. What ratio of species concentrations will be used? How do we account for consumption of species not taken in the sampling event (e.g. maybe shrimp, crab, etc.)