

US EPA ARCHIVE DOCUMENT



County Court Reporters, Inc.  
Stephenson, VA 22656  
www.countycourtreporters.com

Maryland Court Reporting &  
Video Services, LLC  
Baltimore, MD 21218  
www.marylandreporting.com

The Reporters Group  
Stephenson, VA 22656  
www.reportersgroup.com

Court Reporting, Video  
& Litigation Technology  
Pittsburgh, PA  
www.advllegaltech.com

Court Reporting, Video  
& Litigation Technology  
Breckenridge, CO 80424  
www.advllegaltech.com

Corporate: Historic Jordan Springs / 1160 Jordan Springs Road / Stephenson, VA 22656

FIFRA SCIENTIFIC ADVISORY PANEL (SAP)

OPEN MEETING

SELECTED ISSUES ASSOCIATED WITH THE RISK  
ASSESSMENT PROCESS FOR PESTICIDES WITH  
PERSISTENT, BIOACCUMULATIVE  
AND TOXIC CHARACTERISTICS

U.S. ENVIRONMENTAL PROTECTION AGENCY  
CONFERENCE CENTER- LOBBY LEVEL  
ONE POTOMAC YARD (SOUTH BUILDING)

2777 South Crystal Drive  
Arlington, Virginia 22202

OCTOBER 30, 2008

8:34 A.M.

1 FIFRA SCIENTIFIC ADVISORY PANEL  
2 MEETING  
3 OCTOBER 30, 2008

4 **MS. CHRISTIAN:** Okay, good morning,  
5 everyone. We are about to start, please.

6 Again, my name is Myrta Christian. I am  
7 the Designated Federal Official for this meeting, and I  
8 would like to welcome everyone and to thank...to thank  
9 you for participating in today's meeting to continue  
10 the Revision of Selected Issues associated with the  
11 Risk Assessment Process for Pesticides with Persistent,  
12 Bioaccumulative, and Toxic Characteristics.

13 I would like to remind everyone that the  
14 presentations for this meeting are now available on the  
15 EPA docket and that public comments will be available  
16 either this afternoon or tomorrow morning.

17 Now, I would like to introduce Dr. Steve  
18 Heeringa, Chair for the FIFRA Scientific Advisory  
19 Panel.

20 **DR. HEERINGA:** Good morning, again,  
21 everyone, and welcome back to the third day of  
22 our...our meeting with the FIFRA Science Advisory Panel  
23 on the topic of Selected Issues associated with Risk  
24 Assessment Process for Pesticides with Persistent,  
25 Bioaccumulative, and Toxic Characteristics.

1 I said yesterday morning I wouldn't have  
2 individuals introduce themselves again. I think I'll  
3 hold to that. We've had two introductions of the  
4 panel, and if you have any questions about who someone  
5 is, I think you can ask, but so, we'll...we'll move  
6 right ahead this morning.

7 Yesterday, we had moved into the  
8 responses to the charge questions, and we're still in  
9 the process of completing our discussion of charge  
10 question 3. Before we do that, as we generally do  
11 first thing in the morning, is offer the EPA scientific  
12 staff a chance to introduce any comments or  
13 clarifications from the previous day's meeting, and  
14 talking to Dr. Brady, Dr. Faruque Khan, I believe, has  
15 one clarification that he wants to introduce this  
16 morning.

17 Dr. Khan?

18 **DR. KHAN:** Thank you, Chairman. This is  
19 sort of that topic where Dr. Stewart Cohen raised an  
20 issue that he could not reproduce our data. What's  
21 happened is in my input tables, there's two input data  
22 were wrong. It's just a typo.

23 This is the actual revised one, but the  
24 calculation was correct. The calculation doesn't have  
25 anything to do with the data, because I actually used

1 the right number which I already put it in there right  
2 now in the table.

3 Anything else?

4 **DR. HEERINGA:** In other words, you used  
5 the right inputs, just...

6 **DR. KHAN:** Right.

7 **DR. HEERINGA:** ...reported input that  
8 Dr. Cohen then used were that were typos.

9 **DR. KHAN:** That's correct.

10 **DR. HEERINGA:** Okay, I'm glad we...I'm  
11 glad that we have that. I think that Dr. Cohen had  
12 indicated that he may submit a written public comment  
13 today, too, for members of the panel, too, but I'm sure  
14 it was...very much appreciate tracking this down.

15 **DR. KHAN:** Thank you.

16 **DR. HEERINGA:** Very helpful.

17 At this point in time, I think that,  
18 again, talking with Dr. Brady, there will be some  
19 questions of clarification on EPA and EFED regarding  
20 our response to question 3, but since we're not  
21 complete with our response to question 3, we don't want  
22 to anticipate uncertainties, so we'll continue with  
23 comments from the panel members.

24 I think we've had a...an opportunity to  
25 hear from the lead and associate discussants, and

1 they're welcome to offer additional comments if they'd  
2 like, but at this point in time, I'd like to open it up  
3 generally to members of the panel, both assigned this  
4 question and others who would like to comment on  
5 question number 3.

6                   And, again, I think it would be very  
7 useful in terms of the three parts of this question to  
8 focus both on sort of short-term emphasis and  
9 longer-term aims for improvements or additions, and  
10 then, also, I think as Dr. Parker emphasized at the end  
11 of yesterday's meeting, to focus on the sort tiered  
12 screening structure that is routinely employed in the  
13 risk assessments.

14                   So, additional comments on charge  
15 question number 3? Dr. DeLorme?

16                   **DR. DELORME:** All straggling back this  
17 morning. Again, I want to emphasize I come at this  
18 from...from a...a risk assessment practitioner's point  
19 of view, not restricted to incorporating the science  
20 and the policy and understanding how things work, how  
21 the process works within an agency such as EPA or, up  
22 in Canada, EPM. All right? I just want to emphasize  
23 that we have to recognize the fact that the pond really  
24 isn't a pond. Okay?

25                   What I mean by that is it's representing

1 a variety of water bodies, water body types, that, in  
2 generally...in general, based on available information,  
3 track results from monitoring of high-end  
4 concentrations. It's a regulatory reality that we  
5 can't have 100 different scenarios to do for a given  
6 chemical. It just doesn't work. There's just not  
7 enough time to do it.

8           There's no doubt that we need to  
9 incorporate burial in some way, shape, or form. I  
10 think the real question is how and to what extent.

11           Based on the presentations that I saw by  
12 EPA and...and Dr. Frank Gobas at the meeting, the  
13 existing models and the resulting EECs, whether you use  
14 AGRO or whether you use PRZM/EXAMS, are sensitive to  
15 burial and burial rate.

16           The white paper presented results for  
17 burial based on a high burial rate or a high sediment  
18 load going into the pond, and I'm not sure if that's  
19 the optimal approach or not, certainly not  
20 conservative.

21           I think you need to consider getting a  
22 better understanding of sedimentation and burial rates  
23 for various types of water bodies or a scenario for  
24 situations. I mean, certainly, it was evident from the  
25 information presented in the white paper that, you

1 know, a turf situation doesn't result in much sediment  
2 coming...or soil coming off. Therefore, sediment rates  
3 would be lower.

4 So, you might want to consider the  
5 situations, then decide which scenario or scenarios may  
6 be appropriate to bottled based on the problem  
7 formulation. What is it...what's it going to be used  
8 for? Is it going to be used for a row crop in  
9 Mississippi? Well, then, maybe, in a farm pond at  
10 least, or a...a static or semi-static water body, you  
11 know, a high burial rate is...is justified, but in a  
12 flowing water system, it may not be.

13 I think the ultimate goal is to  
14 characterize the risk. Okay? Currently, you kind of  
15 have a one-size-fits-all type scenario, and as Dr.  
16 Thibodeaux pointed out yesterday, I think it's time,  
17 probably, to develop additional scenarios that you can  
18 provide your risk managers with a range of potential  
19 outcomes from these characterizations.

20 **DR. HEERINGA:** Comments from other panel  
21 members? Dr. Thibodeaux?

22 **DR. THIBODEAUX:** Phil, I...I may have  
23 misunderstood you. Did you say that you didn't think  
24 there was any need to go to other aquatic systems like  
25 a stream or an estuary?

1                   **DR. DELORME:**       No, it...no, I didn't.  
2 What I said is that, you know, they need to be  
3 considered.

4                   **DR. THIBODEAUX:**       Thanks. I'm not quite  
5 woke up yet. Sorry.

6                   The...which charge question was the  
7 solubility issue under?

8                   **DR. HEERINGA:**       If that's a test, I'm  
9 failing it, but we'll figure it out. I believe it  
10 would fall, in part, under...I don't believe there was  
11 a...there's no charge question on solubility. Okay.  
12 So, I think it might be an appropriate time to  
13 introduce it if you have some comments, Dr. Thibodeaux.

14                   **DR. THIBODEAUX:**       So...so, it didn't end  
15 up as a charge question?

16                   **DR. HEERINGA:**       There's...that's correct.

17                   **DR. THIBODEAUX:**       So, would you like  
18 comments on it?

19                   **DR. HEERINGA:**       Sure. I think Dr.  
20 DeLorme suggests it's number 2, but you can go ahead  
21 and do it right now. It's an appropriate time, so,  
22 please.

23                   **DR. THIBODEAUX:**       Okay. I...of course,  
24 if you guys would have read my second edition of The  
25 Environmental Chemodynamics, I wouldn't have had to

1 explain this. And I'm a little at fault as well. I  
2 didn't bring a copy, so I can't refer you to page  
3 number. And it has to do something with Don Mackay's  
4 comment about the precip...precipitate solid phase of  
5 pure material.

6 In fact, I think it would be an easy  
7 short-term fix for both EXAMS and, possibly, PRZM, to  
8 go to a hockey stick isotherm. And what I mean by a  
9 hockey stick isotherm is with the input a partition  
10 coefficient, or you calculate it from epi-SUITE or  
11 whatever, but you calculate a particular system once  
12 you have FOC, once you have identified the chemical,  
13 once you get a KOW, but we...somewhere in the process,  
14 you end up with a KD. And that is used in the mass  
15 balance model.

16 You have no constraints on the range of  
17 those concentrations in the water and on the particles,  
18 and the rub comes...and I think now the rubs we saw  
19 when the particles from the...from the PRZM were  
20 diverted, but the chemical is left out, meaning you  
21 have more chemical in.

22 So, what happens is you get a very high  
23 concentration on the particle, and if you use the  
24 equilib...the coefficient coefficient, it demands a  
25 higher than solubility limit.

1 So, what I'm saying is that the  
2 partition coefficient is not an appropriate equilibrium  
3 isotherm for the model. The isotherm should be hockey  
4 stick shaped. You understand what I mean by a hockey  
5 stick?

6 **DR. HETRICK:** I assume you're talking  
7 about a non-linear isotherm?

8 **DR. THIBODEAUX:** Right, yeah, it...it's  
9 like...

10 **DR. HETRICK:** Right.

11 **DR. THIBODEAUX:** The concentration on  
12 one axis, it should go up and then level out

13 **DR. HETRICK:** Right, right, right.

14 **DR. THIBODEAUX:** Now, follow that in  
15 isotherms. The partition coefficient is linear all the  
16 way up, and that's where you get into problems.

17 **DR. HETRICK:** Right, exactly. I guess  
18 one of the questions I have for you on that, just for a  
19 little clarification, is that, you know, with that type  
20 of isotherm, we're...we're making some assumptions  
21 that...well, I guess it may not make a difference. I  
22 don't know if you...if you form a precipitate like AGRO  
23 does versus having that...

24 **DR. THIBODEAUX:** You don't have to do, I  
25 think, if you put it in as an isotherm.

1                   **DR. HETRICK:**       Okay, okay.

2                   **DR. THIBODEAUX:**     I think that would  
3 correct it.

4                   **DR. HETRICK:**       You think that would  
5 correct...that would do essentially...

6                   **DR. THIBODEAUX:**     I think it would  
7 correct it. I understand what Don's doing. I know the  
8 way he thinks. We're both chemical engineers. He's  
9 using an off-site compartment that he--, which  
10 are...which needs a little programing, but I think the  
11 software in your models needs to be...

12                  **DR. HETRICK:**       Doctor, could you just  
13 pull the mike a little closer.

14                  **DR. THIBODEAUX:**     All right.

15                  **DR. HETRICK:**       You turned away for a  
16 minute.

17                  **DR. THIBODEAUX:**     I think I know what Don  
18 is up to, and...but...but I think the existing model,  
19 particular EXAMS and PRZM, can be corrected by toying  
20 with that isotherm.

21                  **DR. HETRICK:**       Well, the...there's a  
22 focused model, actually, that...that has a non-linear  
23 isotherm in it, and...which would...we could probably  
24 modify that to...to...to...and that focus is  
25 PRZM/EXAMS. Now, I'm not sure if the PRZM aspect of

1 that has the non-linear, but I believe the EXAMS does.

2 **DR. THIBODEAUX:** Well, you see, the  
3 catch comes and is that the partition coefficient is  
4 not an isotherm.

5 **DR. HETRICK:** I understand that.

6 **DR. THIBODEAUX:** Good, but we assume it  
7 is in the model.

8 **DR. HETRICK:** Yeah.

9 **DR. THIBODEAUX:** And that's where you  
10 run into the problem. Thank you.

11 **DR. HEERINGA:** Thank you, Dr.  
12 Thibodeaux.

13 **DR. HETRICK:** But I guess my question  
14 is, is that, you know, you've got different processes  
15 here. You have an adsorption/desorption process as  
16 well as a precipitation and dissolution process, and  
17 they're not the same.

18 **DR. THIBODEAUX:** Well, yes, good point.  
19 Partition coefficient going on to the portal-- is what  
20 you need, as opposed to a partition coefficient which  
21 you have a lot of contaminated data that's been...but  
22 that's not your problem when you're...when you're  
23 regulating pesticides, is it? I mean, you open...it's  
24 short-term. You're just putting it on the soil. Then  
25 it goes to the stream.



1           So, why don't the absorption...why can't  
2 you just get by by using those? I mean, us who work in  
3 the contaminated sediment area have to worry about  
4 resorption pollutant issues, because the...both the  
5 chemical and the organic matter in the soils have been  
6 cooking together for the last 50 years, and it's clear  
7 that they're not the same. There's an immobile  
8 fraction that this measure comes off.

9           Is that what you're alluding to?

10           **DR. HETRICK:**       Well, that's part of it.  
11 I mean, that's...that's another complexity to that.  
12 No, I'm alluding to the fact that if you get a solid  
13 base precipitate as what's proposed in AGRO, that's a  
14 whole different process than what...

15           **DR. THIBODEAUX:**    Yes.

16           **DR. HETRICK:**       ...absorption and  
17 desorption is, and...and I believe that modeling the  
18 two, although you could probably get through with a  
19 hockey stick, I'm not sure, mechanistically, you can  
20 say that they're the same. That's all.

21           **DR. THIBODEAUX:**    Well, as clever as Don  
22 is, I...I suspect the answer is pretty close to the  
23 same, but I...I think, theoretically, the hockey stick  
24 would be better, theoretically.

25           **DR. HICKIE:**       And I'd like one comment on

1 that. We...we have done some experimentation in the  
2 past with...with a hockey stick approach, and one of  
3 the problems we've had in using that in the model is  
4 that many pesticide labels will have six applications  
5 14 days apart, and so, if you get new chemical coming  
6 on every 14 days, and so, you have to...so you have a  
7 different lag time in the...in a hockey stick for...for  
8 each time.

9 So, you almost need to simulate each  
10 application as a separate chemical and then add them at  
11 the end, not that we couldn't do that, but...but the  
12 model typically doesn't allow that.

13 **DR. THIBODEAUX:** The model, ideally,  
14 should start with the mass of the chemical from the  
15 previous application and just add more to it. Seems to  
16 me that's the modeling...

17 **DR. HICKIE:** That's true, but the  
18 new...the new chemical, in terms of...of when the...the  
19 actual rate changes, it changes at a certain time after  
20 the application. So, each...each hockey stick, you're  
21 starting at a different point, and the change...change  
22 happens at a different point.

23 **DR. HETRICK:** I think there's a...I'm  
24 not sure, but I think there's a...are you talking about  
25 degradation kinetics, or are you talking about

1 absorption?

2 **DR. HICKIE:** Well, I think either.

3 **DR. HETRICK:** Well...

4 **DR. THIBODEAUX:** My...my comments were  
5 solid. I was strict absorption.

6 **DR. HETRICK:** Okay.

7 **DR. THIBODEAUX:** But there are better  
8 people here to answer that question.

9 **DR. LICK:** Could I comment on the...

10 **DR. HEERINGA:** Let me turn to Dr. Lick,  
11 yes.

12 **DR. LICK:** I'd like to comment on the  
13 linear versus non-linear partitioning, because we did a  
14 whole series of experiments with different organic  
15 chemicals, and, in particular, we did a lot with PCBs  
16 or other very hydrophobic organic chemicals which tend  
17 to have low solubility, and in all of those  
18 experiments, the partition coefficient was linear,  
19 absolutely linear, right up to solubility, and at that  
20 point, of course, the experiment was ended.

21 On the other hand, if we look at  
22 partition...I mean, chemicals with relative lower  
23 coefficients, they tend to have higher solubility, and  
24 there, we did find non-linear isotherms with their  
25 non-linear variation of the partition coefficient as we

1 increased the amount of chemical.

2           If we take all these results, we  
3 can...and normalize them, what we found out was that  
4 the non-linearity starts when the amount of chemical  
5 actually absorbed on the particle starts to become  
6 comparable to the amount of organic matter in the  
7 particle. That...in other words, that's a hell of a  
8 lot of chemical that can be absorbed onto these  
9 particles, but for the very hydrophobic chemical, you  
10 never get near that point, because it's insoluble.

11           On the other hand, the other chemicals  
12 which are...have higher solubility, then, in essence,  
13 you're binding so much chemical to the particle, I  
14 think, that you're actually coating your organic  
15 matter. You cannot add any more chemical to this,  
16 and...and because of that, you get this non-linear  
17 behavior, because the adsorption and desorption to the  
18 surface is no longer the same as in the case where you  
19 have a lot of exposed organic matter.

20           But with high...high hydrophobic  
21 chemicals, the sorption...the partition coefficient was  
22 linear. And that's PTBs and hexachlorobenzene and a  
23 few other chemicals.

24           **DR. HETRICK:**       Just to get back to this  
25 hockey stick concept, should we set the where you start

1 to get the...the...the...essentially, the...the flat  
2 area of that sorption process at the solubility limit?

3 **DR. THIBODEAUX:** Dr. Lick is right. You  
4 can begin to see a curve right then. There's some data  
5 to show that when you get into that region, it begins  
6 to...to curve over, and it's not pure hockey stick, but  
7 you're talking about...that's a minor thing compared to  
8 the other errors we have in this model. So, a 2-line  
9 one might get us through 99.99 percent, but where are  
10 we trying to go?

11 **DR. HETRICK:** I'm...I'm just asking  
12 the...the question is, where do you...where do you draw  
13 the line on that? I guess you're going to set that at  
14 the solubility limits.

15 **DR. LICK:** No, the...the...it starts to  
16 curve over when the amount of chemical sorbed to the  
17 particle tends to become equal to the amount of organic  
18 matter on the particle. So...

19 **DR. HETRICK:** Okay, so...

20 **DR. LICK:** ...we know what the organic  
21 content is, and...

22 **DR. HETRICK:** So, it's independent of  
23 the solubility is what you're saying.

24 **DR. LICK:** Well, up to the solubility  
25 limit. In other words...



1                   **DR. HETRICK:**       Right, but...

2                   **DR. LICK:**       ...if...if you start to do  
3 this and you get the solubility limit, then that's it.  
4 You're at the end.

5                   **DR. HETRICK:**       Right, I understand that.

6                   **DR. THIBODEAUX:**    There was another issue  
7 with solubility which was...had to do with aqisols, I  
8 think. Let me see. I have Keith's. I could work off  
9 of Keith's presentation and the list that he had. See  
10 if I can find it. Sorry, Mr. Chairman. Can I do this?

11                  **DR. HEERINGA:**       Sure may.

12                  **DR. THIBODEAUX:**    Yeah, Keith, what do  
13 you mean by...this is on page 2 of your presentation,  
14 what you gave, the summary, conclusions and fast  
15 forward, and slide number 4, uncertainty regarding  
16 extrapolation of lab-derived solubility values true to  
17 the field. Could you explain where you're coming from  
18 on that?

19                  **MR. SAPPINGTON:**    Sure. The question  
20 there is how representative is a measurement of  
21 solubility in a laboratory, under laboratory conditions  
22 and using the barium instilled water, how  
23 representative is that to field conditions, because  
24 both the procedure that we used in the EXAMS model as  
25 well as AGRO assume that that solubility measurement

1 applies in the field exactly as what was measured in  
2 the laboratory, and there are some...

3 I...I heard comment over the last couple  
4 of days that there may be other factors that would  
5 influence the solubility under field conditions, one of  
6 which may even be spray drift in formulated product  
7 that would come into the pond from spray drift.

8 And just doing a back of the envelope  
9 calculation in...in tox studies, there is a limit  
10 of...of how much you're allowed to add in...in a  
11 particular study for a co-solvents, and that's 1 1/l.  
12 If you were to just mentally do that for a 20 million  
13 liter pond, you would need about 2 liters of co...of  
14 solvent, some sort of solvent material to enter that  
15 pond which is not a tremendous amount.

16 And so, the presumption would be, then,  
17 you might have some sort of solvent effect. I would  
18 say that in mesocosm type studies that are much smaller  
19 systems where the formulated product is added, you  
20 could get some type of...of solvent effect there, and  
21 that's just from the formulated product. You have  
22 other natural lichens and things that...that could  
23 affect solubility as well as temperature and other  
24 things.

25 And so, that question was to say well,

1 we're anchoring everything on this one measurement. Is  
2 that appropriate? Or, at least, give us an indication  
3 of the uncertainty around that.

4 **DR. LICK:** There's no doubt that  
5 co-solvents will modify the solubility, I mean,  
6 enormously in some cases, order of magnitude, and we  
7 did experiments with that also, but there...there's a  
8 paper by Jepson and others, including myself, where all  
9 this, including the non-linear partition coefficients  
10 is discussed. It's also in my book, so it's all there.

11 **DR. THIBODEAUX:** Of course...

12 **DR. HEERINGA:** Dr. Thibodeaux? To make  
13 sure we get your name in there.

14 **DR. THIBODEAUX:** This is Thibodeaux.  
15 Various factors...I believe in the solubility, it's  
16 pure solution. As long as you get the co-solvents and  
17 even particles like DOC, as you go out and sample the  
18 water and measure the concentrations, you may get a  
19 value higher in the field because of these co-solvents  
20 and particles. It would exceed the solubility for a  
21 total concentration. Right?

22 But if you could just between the  
23 particles and get back to water, the pure solution  
24 base, I think you would still see which value would be  
25 solubility. So, you're picking up the extra chemicals

1 by whatever that carrier is from the drift, whatever  
2 the VOCs or other kind of particles that are floating  
3 in the water, that pinpoints a very high concentration.  
4 But that should be accounted for in the model.

5 **MR. SAPPINGTON:** Yes, the model accounts  
6 for partitioning to DOC and TOC, so we're working with  
7 freely dissolved, and I think where the breakdown  
8 occurs sometimes is in the...well, there's an issue  
9 both for predicted as well as measured values, and a  
10 number of the measured values are...are dissolved  
11 concentrations measured through filtration which,  
12 obviously, you can have other smaller precipitates and  
13 co-loyal material in there. And so, the...you know,  
14 there is some uncertainty about what is the freely  
15 dissolved fraction.

16 And that's why we have some guidance  
17 about centrifugation to even separate down further.  
18 But we often are not getting that centrifuge samples  
19 when...when we need it in these cases.

20 **DR. HEERINGA:** I'd like to go to Dr.  
21 Doucette for a comment.

22 **DR. DOUCETTE:** Switch comments now,  
23 first to the co-solvent issue. There's...obviously,  
24 it's been discussed. There's a fair amount of  
25 literature looking at the impact of co-solvents on the



1 solubility, and in terms of that being a...an issue, I  
2 think you hit it right on the head. In...in order to  
3 get a significant enhancement of the concentration in  
4 the...the aqueous phase, the...the co-solvent  
5 concentration has to be very high, probably  
6 unrealistically high.

7           Now, that said, there may be some cases  
8 where the pesticide is applied as a...with a surfactant  
9 formulation in addition that you may get some localized  
10 artificially high solubility for a short period of  
11 time, but generally, once...once it's mixed in the  
12 pond, I don't think that that's probably the...the  
13 issue at all in terms of, you know, super-enhanced  
14 solubility.

15           Second is regard to the...the hockey  
16 stick isotherm and the idea of patching the model that  
17 way, and that certainly is a fix just like the AGRO  
18 approach is to...to artificially pull that out and call  
19 that a precipitate, and neither of them, really,  
20 are...are reality. It's a...it's a fix for, from what  
21 my understanding is, the fact that we're not accounting  
22 for sediment and water continuing to move into  
23 that...that body of water. That is really the  
24 prob...the problem. The solubility can't be exceeded.

25           So, I guess I would rather not put on a

1 fix if I could. I'd rather adapt the model to...to  
2 allow for that to actually mimic reality a little bit  
3 more, and I think Don's approach it's really not a  
4 precipitate, because a precipitate would have kinetics.  
5 It's really just a...a way to pull that...that solid  
6 out and then immediately set it back in to keep it from  
7 exceeding the solubility.

8 I think that might be a better fix than  
9 trying to do a...a hockey stick just because that  
10 hockey stick doesn't really reflect the...the true  
11 isotherm, and the isotherm shape of the curve is going  
12 to depend on the type of soil and the type of...of  
13 chemical.

14 For sediments where it's really  
15 hydrophobic, it is fairly linear, but for compounds  
16 that are less soluble or soils that have low organic  
17 matter, you...you get quite a bit of deviation from  
18 linearity in the desorption isotherm. So, I'd rather  
19 give it the -- typical of the sediment.

20 **DR. THIBODEAUX:** The hockey stick mimics  
21 the Langmuir. Langmuir is a well-known isotherm. I've  
22 got a physical chemist over here who will vouch for it,  
23 and that's theoretically based.

24 **DR. DOUCETTE:** Gas it not really not a  
25 solid.. It's just a convenience.

1                   **DR. THIBODEAUX:**     It's the same...the  
2 same...by the way, I think the same technique should be  
3 used for KOAs. Sooner or later, you're going to get  
4 the same violation of KOAs. You're going to get  
5 chemicals, sooner or later, in your analysis in which  
6 you're going to exceed...the partial pressure is going  
7 to exceed the vapor pressure for the same reason. KOC,  
8 KOA is not an isotherm. It's a fine point. They're  
9 not isotherms. They're the linear extrapolation and  
10 you get the low concentrations.

11                   **DR. DOUCETTE:**     There's no...

12                   **DR. THIBODEAUX:**     It's a compliment I'm  
13 going to get exceedances on

14                   **DR. LICK:**         On the basis of experiments,  
15 I agree with you.

16                   **DR. HEERINGA:**     Yes, Dr. Lick.

17                   **DR. LICK:**         I'm sorry.

18                   **DR. HEERINGA:**     Make sure to say your  
19 name.

20                   **DR. LICK:**         Willie Lick. There's no  
21 doubt that hockey stick or non-lin...non-linear  
22 isotherms are present as you...as you saturate the  
23 system, and that's, basically, what the Langmuir or the  
24 theoretical derivation of the Langmuir curve says, and  
25 that's what we found in the experiment. And it's



1 consistent.

2 **DR. HEERINGA:** Dr. DeLorme and Dr. Gan,  
3 and then I'd like to wrap up at least this round. We  
4 can return to this if we have extra time, but I want to  
5 make sure we maintain sort of appropriate time for the  
6 other charge questions, too, today, but Dr. DeLorme and  
7 then Dr. Gan.

8 **DR. DELORME:** Peter DeLorme. Just a  
9 clarification, Keith. Your assumption is with respect  
10 to solubility that the bioavailable fraction is the  
11 freely dissolved fraction?

12 **MR. SAPPINGTON:** Yes.

13 **DR. HEERINGA:** Dr. Gan?

14 **DR. GAN:** Keith, you mentioned that to  
15 get closer to the freely dissolved concentration,  
16 centrifugation is a better method than filtration, but  
17 centrifugation, still, you cannot separate DON, but  
18 question one or comment one, but there are some other  
19 techniques, I'm sure you know, that like color plates,  
20 microextraction, and some other techniques that people  
21 are working on. They're especially used to measure  
22 freely dissolved concentration.

23 And, you know, the other thing is the  
24 KDOC you mentioned, you know, to get to the freely  
25 dissolved concentration, you can...people can use KDOC,

1 but the fact is for those compounds, the KDOC numbers  
2 are simply not there, I think. You have KOC but not  
3 KDOC. Right?

4 **MR. SAPPINGTON:** And, actually, Dr.  
5 Burkhart has surveyed information on KO...KDOCs, and as  
6 you would expect, there's quite a big range in those  
7 values, depending on the type of organic carbon, and  
8 so, there is information on KDOC. I believe in the  
9 model, KDOC is estimated as a...there's a coefficient  
10 applied to KOW in the organic carbon content used to  
11 estimate that.

12 Lawrence, do you want to add anything to  
13 the KDOC question?

14 **DR. BURKHART:** Could I ask...

15 **DR. HEERINGA:** Dr. Burkhart?

16 Microphone.

17 **DR. BURKHART:** Your point is well taken,  
18 and there's a lot of research going on looking at  
19 partitioning the organic...dissolved organic matter.  
20 There are correlations. I've developed one. The  
21 Europeans have developed some, too.

22 And what the models are doing are...are  
23 using some fraction of the KOW and...and marching  
24 forwards, and that's what we do right now.

25 **DR. HEERINGA:** Thank you, Dr. Burkhart.

1 **DR. LICK:** I just have a...

2 **DR. HEERINGA:** Yes, Dr. Lick.

3 **DR. LICK:** Willie Lick. How do you  
4 define dissolved organic carbon? I mean...and then I  
5 have a follow-up question.

6 **DR. BURKHART:** This is Lawrence  
7 Burkhardt. It's operationally defined as something  
8 passing some type of filter.

9 **DR. LICK:** I know, but what is the  
10 filter, 1 micron, 0.1 micron, what?

11 **DR. BURKHART:** There's no standard  
12 formalized ASTM or OECD cutoff. It's usually something  
13 like 0.4, 0.5 micron or 1 micron, depending on who's  
14 doing it.

15 **DR. LICK:** Okay, then, I'd like to  
16 comment further on that, because, again, we did these  
17 sorbtion experiments, and we had a lot of trouble with  
18 what was dissolved and what was not, and we used real  
19 sediments. Of course, there's a distribution of sizes,  
20 and there's always a little bit of this stuff below 1  
21 micron, and if you filter out 1 micron, you're  
22 automatically putting that in the dissolved state or  
23 the...in the...yeah, dissolved state, and you get a  
24 totally different depend....now, your partition  
25 coefficient suddenly depends on your sediment

1 concentration which doesn't seem reasonable.

2           So, what you have to do is after you  
3 filter...once you filter out a 0.1 micron, then you  
4 part...you've essentially taken out most of the  
5 dissolved stuff, especially if you're working with high  
6 concentrations of sediment, and then your partition  
7 coefficient is a constant, whatever it is, but it's now  
8 independent of sediment concentration.

9           So, it's that 0.1 to 1 which is not only  
10 important, but it depends on your sediment  
11 concentration which is a tough one.

12           **DR. HEERINGA:**       Thank you, Dr. Lick. Dr.  
13 Steenhuis?

14           **DR. STEENHUIS:**     I...I understand that  
15 for the chemical engineers, this absorption and  
16 desorption is extremely important. However, for the  
17 hydrologist, there's also the resuspension of the  
18 sediment and there is more to this model, that is, much  
19 more. And it seems that it is more sensitive to...I  
20 mean, absolutely, the hockey stick is very important,  
21 but it seems also that it's not as important as the  
22 sedimentation rate. The resuspension rate is also very  
23 important, especially if you have a chemical which has  
24 a very short half-life in water and a very long  
25 half-life in sediment.



1           The re...resuspension rate then will  
2 completely determine what the fate of the chemical is.  
3 So...and maybe we also should talk about what...what  
4 model should be long term. I mean the whole model, not  
5 only the absorption partition coefficient, but what  
6 kind of pond model we should take for tier 1, tier 2,  
7 tier 3, and what is long term and what is short term,  
8 and I would like to take a stab at it.

9           Tier 1, I think what is being done is  
10 fine if you look for persistent and non-persistent  
11 pesticide and you sort on that. Tier 2, I agree with  
12 Dr. Thibodeaux that you probably should have...what is  
13 being done is fine, but there should be another version  
14 too, that also sort for different ponds or different  
15 rivers, one which has a high sedimentation rate, a  
16 river which has a low sedimentation rate, and...and an  
17 estuary where we don't know anything about. So...I  
18 have no idea what to do down there.

19           **DR. HEERINGA:**       That's all of the above.

20           **DR. STEENHUIS:**    Yeah, probably. And  
21 tier 3, I think the main problem with tier 3, and you  
22 saw an example of that, plus you can probably simulate  
23 anything, depending on what kind of resuspension rate  
24 you take and what kind of depth of the mixing zone you  
25 take.



1 Dr. Lick presented some equations which  
2 are continuing equations, and they are not that  
3 difficult to implement at all. They...they are the  
4 same... you can in high...in leaching models,  
5 essentially what we're doing is you can assume layer of  
6 fine, I guess, and depending on the diffusion  
7 coefficient, you assume a certain depth, and you can  
8 simulate the effect of dispersive situations very well.

9 So, we're taking more depth, more layers  
10 in the...in the future, not immediately. We're taking  
11 more layers and simulating especially with diffusion  
12 and dispersion between those layers. I think you can  
13 get away from choosing an arbitrary mixing depth.

14 And then, in tier 4, we never...I mean,  
15 I think we can go to the... So, for tier 3, run  
16 conventional model, and for tier 4, really, you need to  
17 simulate the whole system and...and there was talk  
18 about...before about these equations about resuspension  
19 in all these rivers.

20 **DR. HEERINGA:** Thank you, Dr. Steenhuis.  
21 That's val...very valuable to explain. Okay, Dr. Lick,  
22 one more comment.

23 **DR. LICK:** I...I agree with you. I  
24 think there should be a lot of emphasis on this tier 3  
25 taking...essentially, you're taking EXAMS and improving

1 it to make AGRO, and then you're improving it again to  
2 separate that lower benthic layer into three or maybe  
3 five layers where you could talk about the details of  
4 the sediment/water interactions and...and get a good  
5 model.

6           You're right, then you don't have to  
7 worry about defining a thickness which is somewhat  
8 arbitrary. You can also, as you do this, include fine  
9 adsorption rates in the overlying water as you...as the  
10 particles precipitate out.

11           There is one thing that you should do,  
12 and that is the top layer is...the bottom layers  
13 are...are fixed. The top layer has to be variable to  
14 take into account erosion deposition, and once you do  
15 that, I think you have a nice model where you can  
16 investigate ponds, streams, or different conditions in  
17 ponds.

18           **DR. HEERINGA:**       Two more questions. Dr.  
19 Norstrom, comments?

20           **DR. NORSTROM:**       Very quick one. I just  
21 wonder whether people are aware that there has been an  
22 application in EXAMS to an estuary. I just ran into  
23 this paper by McCarthy, et. al. called Modeling  
24 Pesticide Fate in a Small Tidal Estuary, and,  
25 apparently, it works rather well.

1                   **DR. HICKIE:**       We are. We actually funded  
2 that study through a U.S. Geological survey a few years  
3 ago. We have the results. We haven't finalized the  
4 estuary modeling system for the Division, but we are  
5 aware of that.

6                   **DR. HEERINGA:**       Dr. Biddleman?

7                   **DR. BIDLEMAN:**       Well, I...I applaud that,  
8 because I think estuaries are really quite important,  
9 because there's a lot of agricultural land  
10 that...that...that is in coastal regions, and you get  
11 drainoff and...and sometimes fish kills in estuaries.  
12 So, I...I think if...if we're putting an over-emphasis  
13 on farm ponds, I...I think, really, the...the impacts  
14 are more likely to be in estuaries. So, I would...I  
15 would applaud any...any further work to try to  
16 understand pesticide fate in these regions.

17                   **DR. HEERINGA:**       At this point, what I  
18 would like to do is...we've had a lot of discussion, a  
19 lot of information presented and a lot of comment on  
20 this issue, and I'd like to turn to...to Dr. Parker. I  
21 think you've been nominated, I believe, by Dr. Brady  
22 to, I think, come back at the panel with any questions  
23 of clarification that you've had. You've heard a lot  
24 of information. Is there some framework that you're  
25 still looking for? Are there pieces of information

1 that you'd like to hear about or questions you'd like  
2 to have answered?

3 **DR. PARKER:** Yeah, there are...there are  
4 a few questions. I might also ask some of my  
5 colleagues to...to chime in here as well.

6 In terms of the long-term and short-term  
7 question, we have explored the estuary issue. We have  
8 explored the flowing water issue and have not  
9 implemented those at...at this point, but we are headed  
10 in that direction.

11 We will all go home on Friday and...but  
12 next Monday, we will be sitting in our office doing new  
13 exposure assessments for new and...and older chemicals.  
14 And so, one question that we would have is what can we  
15 do in the short term that sort of allows us to...to  
16 move ahead in a scientifically valid manner. I  
17 have...I have a couple sort of sub-questions under  
18 that...under that heading.

19 We have discussed the...the PR Benthic  
20 issue in which EXAMS takes all of the material that is  
21 sorbed in the field and automatically puts half of that  
22 into the water column and half of it into the...into  
23 the benthic layer. Options would be continuing to use  
24 it as it is with a...a...putting half of it each place.  
25 Another option would be, I suppose, automatically tying

1 the percent benthic to a KOC or a KE value so that  
2 something that is more sorbed would automatically go to  
3 the...to the benthic layer. I believe Dr. Lick  
4 yesterday said it's all going there anyway on the first  
5 day or...no?

6                   Anyway, so we could...

7                   **DR. LICK:**       For hydrophobic.

8                   **DR. PARKER:**     For hydrophobic, right, or  
9 hydrophobic...hydrophobic, yeah. So, options would be  
10 using it as it is, eliminating it completely, tying it  
11 to...this is for hydrophobic chemicals...tying it to  
12 some sorption value. Does anyone have a...

13                  **DR. HEERINGA:**    Yeah, let's turn to the  
14 panel on that specific question. We have a fixed  
15 parameter that, right now, is set into this program at  
16 0.5, and that, obviously, has some major implications  
17 for how much of this sorts out fairly quickly into  
18 sediment or water.

19                  Dr. Lick, what would you do?

20                  **DR. LICK:**       There's...there's a  
21 dimensionalist parameter that governs that. It's the  
22 time for desorption as compared with time for settling  
23 of the particle out of the pond, and so, if the time of  
24 desorption is KOW...and I've written that up, actually,  
25 in the notes...is KOW times the settling speed divided

1 by the depth of the pond.

2                   It's a dimensional number, and if  
3 you...if you plot so and so as a function of that, you  
4 get from 1 to 1, and as for any chemical, you can say  
5 as a first approximation, this parameter is so and so,  
6 and, therefore, this is so and so. Okay? It will be a  
7 simple plot.

8                   **DR. PARKER:**       So, using that plot versus  
9 setting the...the...that value...

10                   **DR. LICK:**        Right.

11                   **DR. PARKER:**        ...as the specific default.

12                   **DR. LICK:**        Highly hydrophobic chemicals  
13 would be 1. For low, for hydrophobic chemicals, it  
14 would be zero, and in between, you'll get some  
15 variation.

16                   **DR. PARKER:**        Okay. Is it actually  
17 needed? I mean, will that happen without PR bend just  
18 as a function of the KD of...

19                   **DR. LICK:**        No.

20                   **DR. PARKER:**        It won't. So, that...

21                   **DR. LICK:**        In other words, if you take  
22 your model and run PR bend between 0 and 1, you'll get  
23 different results.

24                   **DR. PARKER:**        Yeah, okay.

25                   **DR. HEERINGA:**        Dr. Doucette, you had

1 a...

2 **DR. DOUCETTE:** A follow-up point to  
3 that, I guess. You actually have...or do you use the  
4 desorption data that you receive in any way?

5 **DR. HETRICK:** No, we're using  
6 adsorption.

7 **DR. DOUCETTE:** Right.

8 **DR. HETRICK:** So, the desorption  
9 coefficients are not being used in the...

10 **DR. DOUCETTE:** But they're available?

11 **DR. HETRICK:** They are available.

12 **DR. DOUCETTE:** Could they be used in  
13 conjunction with Willie's suggestion?

14 **DR. HETRICK:** Yes, that's one  
15 possibility, and...and as Dr. Parker said, the other  
16 possibility is to...and...and I believe it was  
17 presented in the white paper where for a...for the  
18 current estimate of...there's a...there's a  
19 relationship there showing the PR bend as a function of  
20 KOC and how that changes, and we were thinking that if  
21 we could just take that relationship and modify it so  
22 that, in essence, those compounds that have lower KOCs  
23 would have a lower PR bend, and those with higher KOCs  
24 would have a higher PR bend.

25 **DR. DOUCETTE:** But if you actually have

1 the data to support that...

2 **DR. HETRICK:** Oh, I agree with you. No,  
3 I agree with you.

4 **DR. HEERINGA:** Dr. Thibodeaux?

5 **DR. THIBODEAUX:** I'm sorry, I...I think  
6 I got blindsided by this PRN thing. As I understand  
7 it, this is from the PRZM?

8 **DR. PARKER:** From EXAMS.

9 **DR. THIBODEAUX:** From EXAMS?

10 **DR. PARKER:** Just from EXAMS for the  
11 water body model.

12 **DR. THIBODEAUX:** When you enter the  
13 chemical into EXAMS...right...dissolved chemical and  
14 spray drift are automatically partitioned based on  
15 the...the KOC, but chemical that is sorbed in PRZM that  
16 comes off the fields pre-sorbed is automatically routed  
17 half of it to the water column and half of it to  
18 the...to the benthic layer at this point, and you're  
19 wondering what's the best way of using that parameter  
20 might be, whether it's to keep it as it is, to  
21 eliminate it, or to vary it depending on chemical  
22 properties.

23 In the pond...right...you would know the  
24 mass of particles, sediment and solids, and you would  
25 know the mass of water, certainly. The present

1 technique is to assume that that is used...you're just  
2 using--

3 **DR. PARKER:** Yes.

4 **DR. THIBODEAUX:** Okay. Half of the mass  
5 by each...half of the mass of the chemical for each  
6 rainfall event in which there's runoff, half of that  
7 mass is instantaneously dissolved in the water column,  
8 and the other half of the mass is instantaneously  
9 dissolved and completely mixed in the 5 cm benthic  
10 layer.

11 Now, that's the total mass of chemical  
12 leaving the watershed or just that on the solids?

13 **DR. PARKER:** Just that on the solids.

14 **DR. THIBODEAUX:** They're simulated  
15 separately, and the spray drift, then, comes in on the  
16 day of the application.

17 **DR. PARKER:** Yes.

18 **DR. THIBODEAUX:** So, you've got three  
19 entries. You've got spray drift, you've got from the  
20 watershed as a fluid, as water...

21 **DR. PARKER:** Correct.

22 **DR. THIBODEAUX:** ...and you've got  
23 entering the watershed as particles.

24 **DR. PARKER:** Correct. Particles are,  
25 obviously, entrained in the runoff water as it...as it

1 comes off the watershed.

2 **DR. THIBODEAUX:** Right, I understand the  
3 problem. Thank you. Let me think on it.

4 **DR. HEERINGA:** Dr. Parker, additionally,  
5 I think you had a...another follow-up question or  
6 sub-question you had indicated?

7 **DR. PARKER:** Yeah, one...one more. We  
8 are using the static pond as a representative of  
9 flowing and, actually, estuaries as well. The  
10 difference in settling rates and resuspension rates  
11 between static...our static pond and any sort of  
12 flowing water with any velocity at all would be quite  
13 different in terms of burial.

14 Burial for a static...for our static  
15 pond with no flow, everything that comes in, obviously,  
16 accumulates in the pond.

17 In a flowing stream, that chemical would  
18 be temporarily buried by during times of low flow, but  
19 as you have larger storms come through, each larger  
20 storm digs up that old chemical and resuspends it and  
21 moves it on...on downstream. So, the burial would be  
22 substantially lower in flowing water.

23 So, for these hydrophobic chemicals,  
24 does our static...does our static pond continue to be  
25 a...an adequate representative for the flowing water

1 which we now assume it is?

2 **DR. HEERINGA:** And by adequate, you mean  
3 conservative with respect to exposure?

4 **DR. PARKER:** Well, does it...does it...I  
5 mean, is it too conservative, possibly, is...is the  
6 question. Obviously, it is conservative if you're  
7 keeping all of the...all of the sediment and all of the  
8 chemical there, but is it...is it overly conservative  
9 considering that we do represent all flowing water also  
10 with the...with the static pond?

11 **DR. HEERINGA:** Dr. Thibodeaux?

12 **DR. THIBODEAUX:** Right, well, as you  
13 brought that up, I...the first tier, I...I agree with  
14 you. Burial is very important, and I think you need  
15 to...to have it right as far as streams, ponds,  
16 estuaries.

17 I'm using as my model here, the soil  
18 model which I call Universal Soil Loss Equation, and I  
19 think it came up last time, and I'm using that as sort  
20 of a general context to propose that to handle the  
21 different situations, that...that we use...and I call  
22 this...it's a ruse-based model. That's the way I  
23 define Universal Soil Loss. It's got a lot of theory  
24 in it, but you...you really can derive it from scratch.  
25 It's...



1                   **DR. PARKER:**       It's data based.

2                   **DR. THIBODEAUX:**    Data based, yes. The  
3 two primary parameters on selecting...it's important to  
4 select deposition and resuspension which is based on  
5 erosion. As erosion rates...I'd have to defer to Dr.  
6 Will...Lick, but erosion rates are the most difficult,  
7 I suspect.

8                   **DR. PARKER:**       Erosion rate in the field.

9                   **DR. THIBODEAUX:**    In the field, yes.  
10 Now, what about coming up with a matrix in which you  
11 have, on the Y axis, something about flow. Ponds have  
12 low flow, mostly stirred by the winds. Estuaries  
13 fluctuate flow, but they're on the low side. On the  
14 high side, you would have streams. So, on the Y axis,  
15 you've got flow. On the X axis, you have something  
16 about soil type, starting with clay, getting bigger  
17 into silt, and then you get into sand particles.

18                               So, right there, you've got a 9 by 9  
19 matrix. Now, if you could get Dr. Wick...Dr. Lick  
20 to...to...to put you in an erosion rate for each one of  
21 those boxes, then there's the model I'm using for the  
22 soil loss equation. That way, you would have a  
23 template, you know, when you decide, you know, if  
24 you've got a pond, you've got particle size. So,  
25 you've got a little better...at least the next tier.

1                   So, my...my question is, to Dr. Lick is,  
2 you know, could...could...is that possible, that you  
3 could...erosion rates like cm/hour for these type  
4 particles, could you fill that box with reasonable  
5 values? No formulating now. You'd have to...

6                   **DR. LICK:**       Well, we do have an algebraic  
7 formula for how erosion rate changes as a function of  
8 shear stress, but we do not have any formula for  
9 relating erosion rate and this type of sediment to this  
10 type of sediment and so on.

11                   On the other hand, we've done enough  
12 experiments so that we have guidelines with some idea  
13 of how things do change from this box to that box and  
14 this box and yeah, we could give you approximate  
15 numbers for a box or matrix of that type.

16                   But...are you through? I mean, I'd  
17 like...I have some more comments.

18                   **DR. HEERINGA:**     Dr. Lick, I'm going  
19 to...if you would give your comments, and then I'm  
20 going to wrap up on this question, because we...we've  
21 been on it for almost two and a half hours, and I want  
22 to make sure we...

23                   **DR. LICK:**       Yeah, but it's interesting  
24 one.

25                   **DR. HEERINGA:**     It is. Hands down, this

1 is the most interesting topic I have been on for at  
2 least three months, and I've learned a lot, and there's  
3 a lot of expertise, and that's why it's gone on for  
4 three hours. We appreciate it. We certainly  
5 appreciate it.

6 **DR. LICK:** But back to your question of  
7 whether the pond is representative or conservative  
8 enough, I am familiar with some of the major problems  
9 of contaminated sediments. For instance, is it a safe  
10 a river. The question there is you've dumped PCBs into  
11 the river and into the sediments for a long period of  
12 time, and so, you literally have meters of contaminated  
13 sediments, but recent sediments are fairly clean, and  
14 so, the...the top layer is clean.

15 Now, the question is what do you...do  
16 you leave them there, or do you try to dredge them, or  
17 what do you do? The fear is that if you have a big  
18 storm, you're going to erode those clean sediments  
19 which may be only centimeters or maybe tens of  
20 centimeters, and it's certainly possible, in many  
21 cases, but if that happens, now you have contaminated  
22 sediments all of a sudden which then diffuse or get  
23 resuspended into the overlying water.

24 That is the problem on these complex  
25 things, and I don't know how to answer your question,

1 but I'm trying to give you an example of a more complex  
2 situation and the more complex question. Certainly,  
3 you could try to imitate that by a one-dimensional box  
4 model if, you know, with little thought about what was  
5 happening by eroding that...taking that top layer and  
6 throwing it away and seeing what was happening.

7 **DR. HEERINGA:** Okay, thank you very  
8 much, Dr. Lick and Dr. Thibodeaux and all of the other  
9 contributors. Dr. Mehta?

10 **DR. MEHTA:** I have a comment.

11 **DR. HEERINGA:** You haven't spoken yet,  
12 so you might...please weigh in. We're going to be...

13 **DR. MEHTA:** You know, I think there was  
14 a suggestion. The next step from the box model is as  
15 we said the 1-D vertical model, and the...that model  
16 gives you concentration as a function of height, and  
17 it...if you can import current, a weak current, not a  
18 strong current, or a wave, and you put in some  
19 parameters for the erosion which, as you pointed out,  
20 there is...as Dr. Lick pointed out, there is a way to  
21 characterize those within some broad boundaries which  
22 you are not doing and which if you did do it, that  
23 would be...that would be an advancement in technology  
24 as far as collection process is concerned.

25 And the other important part is

1 velocities, and as was pointed out, the erosion in the  
2 field is very difficult to measure, but certain  
3 velocities are easier to measure, because you can use  
4 indices to apparatus to image and improve devices.

5           So, quite often, what we do is you...you  
6 measure the concentration in suspension, and you  
7 measure the settling velocity, and then you run this  
8 model and adjust the erosion rate until you get a  
9 balance...well, if there is a balance. So...and even  
10 settling velocities can be put in the 9 by 9 matrix box  
11 for different kinds of sediments and so on.

12           And also, of course, nowadays, there are  
13 equations available that allow you to...to, you know,  
14 somebody said about...you said about settling in a pond  
15 versus settling under flow. The flow can be a  
16 different type, and there are new equations available  
17 that allow you to actually determine the settling  
18 velocity not only as a function of the settling silt,  
19 sand or place but also the type of flow you've got.

20           So, again, there is a...a  
21 characterization possibility very much exists, and I  
22 think that that would be...that, as you said, it could  
23 be done fairly quickly, although it still would be  
24 approximate. It would be much better than pulling out  
25 these numbers from air.

1                   **DR. PARKER:**       It sounds like that  
2 one-dimensional settling code is available and has been  
3 used. Maybe after the meeting, we can discuss if that  
4 could be something that we might be able to use.

5                   **DR. HEERINGA:**       Certainly, and I think if  
6 there's specific references, as Dr. Mehta says, either  
7 equations or already model modules, definitely mention  
8 them in our report, but if you want to get to that  
9 quicker, I'm sure just a conversation would do it.

10                   At this point in time, I want to thank  
11 everybody who's contributed on this. This was  
12 a...probably one of the more complex questions and,  
13 obviously, one that has a lot of impact in terms of  
14 immediate modeling and risk assessment, and I hope that  
15 we covered everything that's important and that we have  
16 a concise and clear set of recommendations coming  
17 forward.

18                   I would, at this point, like to move on  
19 to charge question 4, and, of course, for those  
20 discussants who still have some points on 3, if we have  
21 time at the end, we will get back to that, definitely.

22                   Dr. Brady, could you read charge  
23 question 4 into the record?

24                   **DR. BRADY:**       Yes, thank you. Charge  
25 question 4: Aquatic bioaccumulation methods.

1 Traditionally, LPP's assessment of pesticide  
2 bioaccumulation potential in aquatic organisms has  
3 relied extensively on the use of bioconcentration  
4 factors. BCFs consider direct chemical uptake through  
5 aqueous exposure routes only.

6 For organic chemicals with PBT  
7 characteristics, bioaccumulation from non-aqueous  
8 exposure routes can be substantial. For these  
9 chemicals, risk assessments and other Agency programs  
10 have used the combination of laboratory, field, and  
11 model-based methods for incorporating bioaccumulation  
12 via multiple exposure routes.

13 In the pesticides program, a similar  
14 integrative approach is being considered for assessing  
15 the bioaccumulation potential of organic pesticides  
16 with PBT characteristics. This approach considers the  
17 type and quantity of data typically available for  
18 pesticide ecological risk assessment, relative  
19 strengths and limitations of each bioaccumulation  
20 assessment method, and uncertainty associated with  
21 bioaccumulation predictions using each method.

22 Please comment on the need to consider  
23 alternatives for the BCF method for assessment the  
24 bioaccumulation potential of organic pesticides with  
25 PBT characteristics.

1 Please comment on the applicability of  
2 the Agency's approach of using multiple methods for  
3 assessing bioaccumulation potential of organic  
4 pesticides as illustrated in the white paper.

5 **DR. HEERINGA:** Thank you very much. Dr.  
6 Hickie is our lead discussant on question 4.

7 **DR. HICKIE:** I have a presentation.  
8 Would you load it, please?

9 I'd just like to start by acknowledging  
10 my co-discussants. We had some very lively discussions  
11 on this topic. James Oris, Jim Meador, Kirby Donnelly,  
12 and...and Daniel Schlenk, and I'm sure they'll weigh in  
13 with some comments.

14 Next slide.

15 To make the answer to question 1 very  
16 short, it's a...almost a one-liner, and that...that is  
17 that the BCF method is clearly inadequate for assessing  
18 organic PBT pesticides, and we can elaborate on...on  
19 that, mostly under question 2.

20 Next slide.

21 Just...just briefly on this question,  
22 some of the alternative approaches that we gave some  
23 thought to, obviously, we need to address accumulation  
24 from multiple pathways, water, diet, and sediment,  
25 trophic transfer or biomagnification when and where it

1 occurs, and biotransformation is an ongoing headache in  
2 this realm.

3                   And some of the other issues that...that  
4 we'd like to address that particularly tie into  
5 modeling work is borrowing Dr. DeLorme's comment he  
6 made to me yesterday, is we need greater ecological  
7 reality. And that...that encompasses a number of  
8 things, many of which have been addressed in...in the  
9 white paper.

10                   We'd include temporal variability and  
11 chemical exposure, the need to address bioaccumulation  
12 as...as a non-steady state process, and greater  
13 environmental variability incorporated into probably  
14 the EXAMS model and...and the bioaccumulation models.  
15 And one example of that is that temperature is an  
16 important driver of things like metabolic rates in  
17 organisms, and that has a large influence on...on  
18 chemical kinetics.

19                   More comprehensive view on the aquatic  
20 food web, and in the discussion over the last few days,  
21 there...there are several suggestions. Dr. Simonich  
22 brought up the point of amphibians. She beat me to  
23 the...that question.

24                   And, of course, fish-eating birds and  
25 mammals are...are discussed in a limited way in

1 the...the white paper, and I think we need a more  
2 comprehensive approach to dealing with them. And in  
3 the white paper, they...they really just use one sort  
4 of generic food web in...in the area of plankton and  
5 fish, and we had some discussion as to whether that was  
6 perhaps adequate, given the geographical range that  
7 we're dealing with.

8 And that's...that's the extent of  
9 comments I have for question 1. I think we get into a  
10 lot of the details in...in question number 2.

11 **DR. HEERINGA:** Question number 2, you  
12 mean the second part of question 4?

13 **DR. HICKIE:** Yes.

14 **DR. HEERINGA:** Why don't you ugo ahead  
15 and present...

16 **DR. HICKIE:** Okay.

17 **DR. HEERINGA:** ...those, and then we'll  
18 have a...

19 **DR. HICKIE:** Okay.

20 **DR. HEERINGA:** ...your associates'  
21 comments.

22 **DR. HICKIE:** So, on...on the second  
23 question, it asked us to comment on the Agency's  
24 approach of using multiple methods, and just summarized  
25 here the...the different approaches, and maybe I put

1 some of these in my own language as opposed to taking  
2 them direct from the...the white paper.

3 But there's essentially five of them,  
4 lab studies to measure BCFs, and other lab studies  
5 which can...was a mix of things ranging from  
6 microcosms, biosediment accumulation factors. There's  
7 perhaps several other tests that I...aren't coming into  
8 my mind at the moment.

9 Number 3 is...is controlled field  
10 studies such as mesocosm. Number 4 is open field  
11 studies using natural food webs, and...and the point  
12 was brought up that that's not all that applicable for  
13 new chemicals. And number 5 is bioaccumulation  
14 modeling.

15 The strategy that I...I see going  
16 forward...and it's...it's...it's really in the white  
17 paper, but it's maybe not explicitly stated as  
18 such...is that at the core of this is and should be  
19 bioaccumulation modeling and...and that lab studies, in  
20 particular, should be focused on providing information  
21 to...to verify or refine inputs to these models.

22 And this is the desirable approach for a  
23 number of reasons, relatively low demand on time and  
24 resources. That was mentioned. And the modeling  
25 approach gives the potential to deal with a range of

1 issues in...in a holistic manner. And I think a  
2 good...another good thing is...is that there's a  
3 variety of existing models that...that, at a minimum,  
4 provide a good starting point, if not take us well down  
5 the road to doing this. And...and I could add one more  
6 point, that it will keep modelers such as myself  
7 perhaps busy for the...the remainder of my career.

8                   Next slide, please.

9                   So, in this strategy, the idea of the  
10 lab studies is that they...they provide data for  
11 validating the assumptions of the model by...by looking  
12 at the data compared to predicted values for...for  
13 things like gill uptake and elimination rate constants,  
14 and if they agree, then it gives you some confidence as  
15 you move forward, and if...if they don't, it gives the  
16 amount that you would need to refine model parameter  
17 values on a chemical-specific basis. And...and we  
18 actually saw efforts to do that, primarily with  
19 chemical 4, in the white paper.

20                   Next slide.

21                   Any time you use models, you...you...you  
22 have to use them wisely, and you need...for that, you  
23 need a sound knowledge of their limitations, or you can  
24 use them where you shouldn't be using them or where you  
25 should use them with caution.

1                   And, for example, pretty well all the  
2 bioaccumulation models I've worked with or see don't  
3 work particularly well with polar or ionic compounds.  
4 I don't think anyone's managed to...to get a model  
5 that...that works consistently for them.

6                   And, of course, you need to understand  
7 the uncertainties both in the model structure and those  
8 associated with the...the inputs and the outputs of the  
9 model.

10                   Next slide.

11                   Just now going into some of the  
12 particular issues that I thought of and had some  
13 discussions with...with my colleagues, question of...of  
14 KOW, very important input parameter of the model, but  
15 it...it also provides guidance of...of when  
16 bioaccumulation modeling is required. And if you go  
17 through a model like the Arno & Gobas model and...and  
18 work through it, it would suggest that you really need  
19 to start paying attention to dietary accumulation for  
20 the plankton and fish food web somewhere around log KOW  
21 4.5 and upward.

22                   If you bring in modeling for birds and  
23 mammals, that start point is at a...a lower log KOW,  
24 and I'm suggesting somewhere about 3.5. I could  
25 probably refine that number with a little bit of

1 thought.

2                   And...and there's a number of reasons  
3 for this. First off, there...there aren't...they're  
4 breathing organisms, they're warm-blooded, and...and by  
5 breathing air, they're...they're...the respiratory  
6 elimination pathway is...is not as important in  
7 general.

8                   Another point I'd like to make that...is  
9 that many bioaccumulation models, particularly  
10 with...with aquatic organisms, are really faced with  
11 the challenge of...of calibration for what I refer to  
12 as super-hydrophobic chemicals in that there simply  
13 isn't very good data or an abundance of it to calibrate  
14 certain...some of the values, again, such...such as  
15 gill uptake and elimination rate constants, and that  
16 becomes a problem somewhere in the range of log KOW 7  
17 to 7.5.

18                   And the last point I'd like to make with  
19 KOWs is...is...and we all face it...is finding reliable  
20 values of KOW to work with. This has been discussed  
21 for many years, and it's particularly problematic when  
22 you get to very hydrophobic chemicals. So, in any  
23 process, you...you need a means of...of vetting or...or  
24 looking carefully at the available values and trying to  
25 pick the best one as opposed to just picking the...the

1 average of them.

2 Next slide.

3 There was quite a bit of discussion at  
4 various points about the utility of bioconcentration  
5 factors, and in thinking about that, bioconcentration  
6 factor tests, even with very hydrophobic chemicals, can  
7 still provide very useful information if they are done  
8 properly.

9 An important aspect of that is...is when  
10 you look at an aquatic food web, the single largest  
11 step increase in...in concentrations in an aquatic food  
12 web is that initial partition from water into the small  
13 organisms, phytoplankton or...or zooplankton, and  
14 bioconcentration factors are...are the best thing to  
15 describe that process.

16 Out of the bioconcentration factor  
17 tests, you can get information on bioavailability,  
18 uptake, elimination kinetics across respiratory  
19 surfaces. You can get some idea of...you can either  
20 verify the time to steady state, or you can get some  
21 idea of...of how long it might take if...if it's a  
22 kinetically-derived BCF.

23 The utility of these tests is...is  
24 increased considerably if additional information is  
25 reported. Fish size, growth rate, lipid content

1 are...are important things. The reason for that  
2 is...is with that kind of information, you can scale  
3 the bioconcentration factor to other sizes or...of fish  
4 or ones with different lipid contents, and...and you  
5 can tease out the effect of growth rate on...on  
6 uptake/elimination rate constants.

7           And bioconcentration factors can also  
8 provide some information on whether a...a chemical is  
9 subject to biotransformation, simply if the BCF is  
10 substantially lower than...we've got an echo back  
11 there...if the bio...if the bioconcentration factor is  
12 substantially lower than you might predict from KOW or  
13 KOW-based partition.

14           Of course, there was a lot of discussion  
15 about the...the caveats of using BCFs, and...and  
16 we've...we've included, of course, discussion about  
17 exceeding water solubility, the use of co-solvents, and  
18 whether, indeed, some BCF tests give sufficient time  
19 for...for the chemical to reach steady state. And I  
20 think a problem there is that some standard protocols  
21 may need to be revisited to allow time to steady state  
22 or to simply accept that...that BCFs would have to be  
23 derived from ratios of uptake and elimination rate  
24 constants.

25           Next slide.

1           The thinking about the food web model,  
2 then, first off, I...I think that a model like...such  
3 as Arno & Gobas has developed is...is fundamentally  
4 sound in...in concept, and the equations are fine, and  
5 there may be some challenges in...in calibration and,  
6 as I mentioned, its application for very hydrophobic  
7 chemicals, and it could be a bit of a problem.

8           But there's a num...a number of other  
9 issues that...that we think could potentially get  
10 worked into food web model. Refining food web  
11 structures to reflect dynamic modeling, I...I brought  
12 up the point that in the version that...that Frank was  
13 presenting, his 1 kg fish modeled over 30 years was the  
14 same 1 kg fish, but it still had a growth rate.

15           And...and the way to address that is you  
16 have to introduce each classes which...which makes  
17 it...makes the model more complex and...and so, you  
18 have a constant turnover of...of...of the 1 kg fish  
19 as...as you progress through...through the simulation,  
20 and that adds a fair bit of effort, but I...I know  
21 Frank Gobas has a different version of the model  
22 where...where he has done that.

23           Another very important point in any of  
24 these models is...is to...and perhaps, particularly, in  
25 the pond model...is the percent benthos represented.

1 In the diet in the generic food web that all the  
2 simulations used, several species had 50 percent of  
3 their diet from...from the sediments, and I don't quite  
4 know where that's coming from as to whether it's a best  
5 guess, but it...it's something that definitely needs to  
6 be considered carefully, particularly for high KOW  
7 chemicals.

8 Water temperature is...is an example of  
9 an environmental characteristic that...that probably  
10 needs to be better incorporated, and I think Dr. Gobas'  
11 simulations and...and, I believe, the ones in the white  
12 paper used a...a constant water temperature. And  
13 several good papers, one of which was just out last  
14 year by Andrea Buchman, et. al., that...that shows that  
15 water temperature is...is a major driver of elimination  
16 rate constants for PBT chemicals. She was principally  
17 working with...with PCBs.

18 And the background to that is...is...is  
19 that these are cold-blooded animals, so water  
20 temperature is a major driver of...of the bioenergetic  
21 aspects of these models, driving respiration rates,  
22 feeding rates.

23 And, additionally, growth of...of fish  
24 is...is a temperature-dependent function, and, I  
25 believe, in the Arno & Gobas model, they...they plug in

1 a...a set growth rate that...that doesn't reflect  
2 temperature, and, for that matter, it's also not  
3 connected to the feeding rate that they plug in, and as  
4 we all know, if you eat more, you tend to grow.

5           One aspect that is not addressed by  
6 these food web models is...is the fact that,  
7 particularly at the base of food webs, is...is that  
8 biological production is a significant source of  
9 organic carbon in many systems, and in a place like an  
10 aquatic pond that's receiving a lot of nutrient input  
11 along with the pesticide runoff, there can be  
12 sub...substantial algal or macrophyte production, and  
13 this, perhaps, needs to be addressed in some way  
14 in...in the concept of...of it has the potential to  
15 bio-dilute the concentration of chemicals in the  
16 system.

17           And bringing in additional species,  
18 there's a number of issues here. If...if...and it  
19 depends on...on the...the detail you want to get into  
20 with the biology of the animal and...and their  
21 particular life history. Amphibians, for example, go  
22 through egg, tadpole, adult stages, and amphibians are  
23 also partly aquatic and...and terrestrial at times, and  
24 that creates a...is an example of a significant problem  
25 with the aquatic/terrestrial overlap in food webs.



1                   And birds and mammals are...are a  
2 particular problem, again, because their biology and  
3 life history may be kind of difficult to incorporate  
4 into the type of model that...that...such as the Arno &  
5 Gobas model, and I talk about that on the next slide.

6                   Just start by making the point that the  
7 treatment of birds and mammals in the aquatic  
8 bioaccumulation chapter of the white paper is...is in  
9 stark contrast to where we've gone with the sort of  
10 plankton to...to fish modeling where we've gone to  
11 really quite elegant dynamic model that tracks temporal  
12 changes in concentrations all the way through the food  
13 web, and...and yet...and with that, there's a really  
14 wonderful thing that now you can take different time  
15 averaged concentrations to...to calculate acute and  
16 chronic risk quotients based on the 1 in 10-year peak  
17 exposures and things of that.

18                   And when...when we get to bird and  
19 mammal approaches, we take information from...from the  
20 primarily fish data and really just plug it in and  
21 calculate sort of a single point estimate of exposure  
22 in terms of sort of daily dietary intake, and there's  
23 no consideration of...of time to steady state for birds  
24 and mammals, which may be substantially longer than  
25 many of the lower trophic level organisms.



1                   And so...so, that brings up, you know,  
2 the...the challenge of the need for dynamic modeling of  
3 birds and mammals and how do we incorporate that into a  
4 tiered approach.

5                   And I think one...one thought I have on  
6 that was that we...we could look at the relatively  
7 simple risk quotients and...and where they've played  
8 relative to the...the levels of concern, and...and if  
9 they're substantially higher than the level of concern,  
10 maybe you don't need to go to dynamic modeling to...to  
11 evaluate risk, nor do you have to do it if...if the  
12 risk quotients, these simple risk quotients, are  
13 substantially below the level of concern.

14                   And I...I think the gray zone is where  
15 things are hovering around the level of concern  
16 and...and perhaps, then, dynamic approach might better  
17 answer questions regarding risk for birds and mammals.

18                   I think another very important point  
19 of...of better incorporating birds and mammals into  
20 these food web models is if it provides estimates of  
21 tissue concentrations which very nicely dovetails with  
22 the good idea of using critical body residues to  
23 estimate toxicity, and I think we'll talk about that a  
24 little bit in question 6.

25                   Next slide.

1                   Again, birds and mammals, there are some  
2 good models out there that could either be used or...or  
3 modified for use, and I've just thrown up a few  
4 examples. Ross Norstrom and his former student, Ken  
5 Riard, have a very nice ... model. John Nichols with  
6 EPA has...has a nice example of one with tree swallows  
7 which, as...as an interesting twist, that...that a good  
8 part of their diet are emerging insects from ponds.

9                   And the Gobas group...and we'll talk  
10 about these in a little bit in...in the next  
11 question...has...has models that...that work for  
12 mammals...mammals. And my own work is principally on  
13 marine mammals, but I'm in the process of turning the  
14 marine mammal into a...a mink which...which modelers  
15 can do.

16                   And...and I'm not advocating that we  
17 could necessarily go and start modeling marine mammals,  
18 al...although the question of loading as to estuaries  
19 came up, but these models certainly provide a nice  
20 starting point in...they all have a sort of similar  
21 basic structure.

22                   And it...it makes it relatively  
23 simple...I'll never say easy...to adapt them to other  
24 species in that there's really four main elements here  
25 that...the biology and life history of the organism,

1 bioenergetics, and the need to define the diet which  
2 can be quite tricky, and...and the chemical kinetics  
3 and so...so, shifting them from one species to another  
4 is...is substantial work, but...but you're not starting  
5 from scratch.

6           Next slide. We did discuss the issue of  
7 biotransformation, and the consensus seems to be...and  
8 the approach taken in the white paper is fundamentally  
9 sound, that there's currently no reliable means to  
10 predict the rate constant KM that goes into these  
11 models, so you have to get it experimentally. And if  
12 you don't have that data, I think, starting with the  
13 assumption that...that it is value of zero is...is  
14 the...the conservative approach.

15           I'd like to make a couple of points  
16 here, is...one is just because you...you have  
17 experimentally derived metabolic rate constant  
18 for...for producing degradants, you have to be careful  
19 in extrapolating it between species. And one example I  
20 can give is work that I've done...and...and Ross  
21 Norstrom could also comment on this...is if you look at  
22 PCB metabolism in seals versus Beluga whales versus  
23 polar bears, you see very, very different things.

24           Beluga whales are not particularly good  
25 at metabolizing PCBs. Seals are quite good at

1 degrading many PCB congeners, and...and when you get to  
2 polar bears that primarily eat seals, there's perhaps a  
3 half dozen congeners that dominate. So, it...you have  
4 to be cautious when you...you do that.

5           Another point in biotransformation is  
6 that bioaccumulation models that are out there right  
7 now don't really deal with metabolites that's chemical  
8 degraded that actually disappears from the model. And  
9 if you were to try to apply these models to  
10 accumulation or elimination of degradants as...as  
11 chemicals out in the environment, just a caution that  
12 these models are largely developed for...for neutral  
13 organics. So, if the degradants are polar or ionic,  
14 you're...you'll...you'd be in trouble.

15           Next slide.

16           So, the solubility  
17 bioavailability...bioavailability and bioaccumulation  
18 issue that...there was a lot of discussion this morning  
19 about solubility, and I...I think the white paper  
20 addresses this quite well with respect to  
21 bioaccumulation, but one point I would make to...like  
22 to just go through again is that our definition of  
23 solubility is operationally defined. So, if you use a  
24 different method, you get a different outcome,  
25 and...and as such, just thinking about this, what we

1 use as dissolved may not be synonymous with  
2 bioavailable.

3           And...and this is something that we've  
4 usually assumed that once we calculate what the  
5 dissolved should be, we assume that's bioavailable,  
6 but, of course, our measure of dissolved really depends  
7 on how we calculate it or...or measure it.

8           And while I'm on being a grammar cop,  
9 I'd just like to point out that the term equilibrium  
10 and steady state are not synonyms.

11           And also gave a little bit of thought to  
12 long-range transport and...and the bioaccumulation  
13 issue, and can't really say much on that yet, because  
14 we don't have any...there's no way of addressing the  
15 issue of loading into an aquatic ecosystem at this  
16 point, and you need that loading before you do any  
17 bioaccumulation modeling.

18           I think that's gone backwards. So,  
19 that's it for my comments.

20           **DR. HEERINGA:**       Thank you very much, Dr.  
21 Hickie, for the organization and presentation of your  
22 comments.

23           I'd like to give the associate  
24 discussants a chance to add comments to what Brendan  
25 has already provided. Dr. Oris?

1                   **DR. ORIS:**       Jim Oris. I think that Dr.  
2 Hickie's done an outstanding job of summarizing the  
3 discussions that we had on this, and I don't have a  
4 tremendous amount to add, but I do want to touch on a  
5 few details that...that are critical for me as I see  
6 some of these things.

7                   First of all, you need to get this part  
8 right, because if you're going to use critical value as  
9 it is to toxicity, this part has to be done correctly.  
10 So, it's really critical for this part to be done  
11 correct.

12                  I'll reiterate some of my comments that  
13 I made yesterday about the transparency of the  
14 assumptions that you make that need to be put up front  
15 in the problem formulation stage so that everybody  
16 knows going in what the assumptions are, when they're  
17 violated, and the implications of those violations. As  
18 we know, all models are wrong; some are useful.

19                  These models are wrong, but they're very  
20 useful, and if you violate the assumptions, then they  
21 don't...they lose their utility. So, just be very  
22 transparent in...in what the assumptions are.

23                  In terms of methods that are used  
24 and...and looking towards a tiered approach for PBT  
25 chemicals, the...the laboratory-based BCF methods don't

1 address potential for trophic transfer, and they  
2 shouldn't, but if you have a PBT chemical, there is a  
3 test guideline for a laboratory-based assessment of  
4 trophic transfer, and maybe you should implement that  
5 as a...as a tiered step.

6           There is a need it incorporate growth  
7 and metabolism in the model. There's a need to  
8 incorporate dealing with solubility issues, and I would  
9 encourage you to continue pursuing the use of the AGRO  
10 version of the modeling that you're using.

11           You must look at ranges of dissolved  
12 organic and particulate organic matter in your  
13 modeling. Currently, just fixing it at one particular  
14 value, I don't believe, is sufficient if you're looking  
15 at a range of...of ecosystems.

16           And some of my comments are random,  
17 because I'm reading through some bulleted points here,  
18 so bear with me if I jump around just a little bit.

19           In current BCS laboratory methods,  
20 there's a strong encouragement to reach some kind of  
21 steady state level in the organism, and with PBT  
22 chemicals, that may not be possible. In fact, if you  
23 have a steady...time to steady state of several hundred  
24 days, unless you have a Willie Lick student, you're not  
25 going to get there.

1                   Mathematically, it's clear that you can  
2 use the ratio of the uptake and elimination rate  
3 constants to estimate a pretty decent value for  
4 bioconcentration factors, and, in fact, it may be more  
5 accurate for PBT chemicals, since you can't get towards  
6 that steady state. But a reliance on those rate  
7 constants, I'll encourage you to be very careful about  
8 how you use those and the assumptions that go into  
9 them.

10                   And an example is in Table 5.18 on page  
11 139 in which there's rate constant that's listed from a  
12 different kind of a model. So, when you have an uptake  
13 rate constant that's less than 1, chances are it was  
14 done using a different kind of a model, and there's at  
15 least one in there.

16                   If you use a mass-based rate constant  
17 which that one is and you try to apply it to the models  
18 that you're using, you'll have some significant error.  
19 So, be very careful about the kind of model.

20                   There are mass-based models, and there  
21 are concentration-based models. You're using a  
22 concentration-based model, and you need to make sure  
23 the units are correct.

24                   Saying that, if you...you can't assume  
25 that a liter of water and a kilogram of organism are

1 equivalent. So, by publishing or reporting units for  
2 the rate constant, for, especially, the uptake rate  
3 constant of just inverse time, 1 over days, is not  
4 appropriate. It must be in liters per kilogram-day,  
5 and the same thing with bioconcentration factors. A  
6 liter of water does not equal a kilogram of organism.

7           And when you go to do the calculations  
8 for the CDRs if you don't carry those units through,  
9 you won't end up with the right calculations. It's  
10 just a technical caveat that you really need to be  
11 careful about.

12           You can also use information from the  
13 bioconcentration factor test if you do a little bit of  
14 extra effort to look for things like metabolism, or  
15 when you are interesting in adding extra tiers for the  
16 critical body residue, if you can find different  
17 compartments in the organism. Again, the model is  
18 wrong. You assume that an organism is one compartment,  
19 but you can look at the elimination phase for multiple  
20 slopes on the elimination constant and determine  
21 whether there's more than one compartment.

22           If there's more than one compartment,  
23 perhaps the assumption of the organism either  
24 non-metabolizing or multiple compartments for target  
25 organisms may not be an appropriate assumption when you

1 go to the next phase. So, it's a potential we can  
2 highlight these for further study.

3 I think that's all I want to add right  
4 now. Thank you.

5 **DR. HEERINGA:** Thank you very much, Jim.  
6 James Meador?

7 **DR. MEADOR:** Hi, Jim Meador. I also  
8 thought Brendan did an excellent job of summarizing the  
9 various points...points in our thoughts. I'll add just  
10 a couple of things.

11 Brendan made a point about pri...primary  
12 production in ponds, and what I found in...in my copper  
13 work with the microcosm is that algae were actually  
14 quite leaky, and they lose a lot of dissolved organic  
15 carbon. And, actually, microcosm hit with massive  
16 concentrations of copper could actually recover just by  
17 the dissolved organic carbon, dissolved organic  
18 material when this algae was leaked. So, I think  
19 that's an important; point also to consider.

20 I also had a comment about  
21 biomagnification factors. I really don't think you had  
22 that as part of...as part of your protocols, and I know  
23 you have a trophic transfer test, you know, that really  
24 is two trophic levels or more. So, I don't know if you  
25 address that through modeling or if you

1 consider...considering actual biomagnification tests or  
2 how you're thinking about that.

3 **DR. HEERINGA:** Dr. Sappington?

4 **MR. SAPPINGTON:** Yes, there's a...a  
5 trophic transfer test which is usually a...a feeding  
6 study just to get at the transfer between two trophic  
7 levels. I think for addressing multiple trophic  
8 levels, the approaches would either be modeling or  
9 using mesocosm type studies where you actually include  
10 several trophic levels in...in the experiment.

11 **DR. MEADOR:** Okay. And I also wanted to  
12 make a point about this concept of using KOW to  
13 determine the importance of water versus dietary  
14 exposure. That's based on equilibrium modeling, and  
15 rarely in an environment do you have equilibrium. So,  
16 you can have an animal that accumulates a fair amount  
17 even at a low KOW, a particular compound at low KOW,  
18 move out of the area, still have a lot, and be a very  
19 important component for the dietary. That low KOW can  
20 actually be very important. It's not...it's not just  
21 based on KOW.

22 That pretty much covers my extra points.

23 **DR. HEERINGA:** Thank you, Dr. Meador.  
24 Dr. Donnelly?

25 **DR. DONNELLY:** I really don't have much

1 to add. I...I do think Dr. Hickie did an outstanding  
2 job of summarizing our discussions.

3 And, quickly, I...I think I want to put  
4 in a plug for potential alternative field-based  
5 methods. We've been doing a study with...in  
6 collaboration with Dr. Meador and...and some of the EPA  
7 Region X Superfund folks for about five years now up  
8 in...in Region X.

9 And at the request of the EPA last  
10 summer, we incorporated a solid phase microextractor to  
11 look at bioavailability and bioaccumulation of  
12 sediments. And, certainly, we don't have the results  
13 from that, but it seems like a pretty nice tool for  
14 field-based methods. And given the variability of  
15 sediments both within a site and from site to site, it  
16 may be an option for...for looking at bioavailability  
17 and bioaccumulation.

18 **DR. HEERINGA:** Thank you, Dr. Donnelly.  
19 Dan Schlenk?

20 **DR. SCHLENK:** Last but not least, I'd  
21 also like to thank Dr. Hickie for summarization of...of  
22 our discussions yesterday and...and previous days.

23 I just...a couple things to highlight  
24 it. I think in a tiered approach, you're...the models  
25 that you have seem to be...work pretty well for

1 your...for compounds of about 5.

2 A log KOW of 5 or less seem to...to be  
3 pretty...pretty nice in terms of at least what was  
4 presented in the white paper, particularly some of the  
5 hybrid models with the AGRO/PRZM/QUASI and the Arno &  
6 Gobas 04 model. The dynamic model seemed to coincide  
7 pretty well with some of the...the predictions of the  
8 empirical data. So, I think that looked pretty good to  
9 me anyway.

10 Unfortunately, I guess, for the  
11 compounds that are fairly high that tend to...you have  
12 some issues with that, and it's tough to...to model  
13 that.

14 So, in terms of sort of revisions,  
15 it...I think Dr. Hickie had brought up, but just a  
16 little bit more detail and also to re...reiterate some  
17 of Dr. Oris' comments.

18 I think, from a tiered approach, the  
19 kinetics can tell you a lot in terms of whether your  
20 not you had inflection points in terms of uptake or  
21 elimination. I think those are...are critical in terms  
22 of the tiered approach that could drive you towards,  
23 you know, a different hypothesis testing in that  
24 regard.

25 One of the things...and, again, it's

1 interesting, Keith, you brought up the...the solid  
2 phase microextraction. We've...in our group, we've  
3 been seeing, actually, the potential input of...of oral  
4 exposures being fairly significant with compounds log  
5 KOWs about 3 to 4. We haven't gotten up to 7 or 8, but  
6 it would make a lot of sense, given the discussion of  
7 the last question, that you are getting interactions  
8 with DOC or forms of DOM, that colloidal material,  
9 that, again, how you define this, you know.

10 We are seeing uptake from oral  
11 absorption primary from a...from benthic mass  
12 invertebrates as well as...as well as a fish study that  
13 we've seen. So, consequently, with an oral exposure, I  
14 think metabolism becomes much more important in that  
15 regard, particularly the...the hepatic metabolism that  
16 you get with some of these compounds. Not all of them.

17 Obviously, it's...you know, it's not a,  
18 you know, one size fits all type of thing, but...but I  
19 think one of the things you could explore in terms of  
20 refining, perhaps, some of these models with a high/low  
21 KOW would be looking at...at that as...as a route.

22 And I think, you know, size does matter  
23 in terms of...of what those particle sizes are. I  
24 think the information that we're getting out of animal  
25 materials and now particles is demonstrating that, that

1 we are seeing absorption from the aqueous environment  
2 and some of these aggregate type compounds that are  
3 less than the 1 micron that go into...what are  
4 dissolved per se but are actually being absorbed and  
5 taken up.

6                   So, consequently, I think that's  
7 something that you might want to refine in terms of a  
8 near-term sort of recommendation.

9                   From a more futuristic perspective...and  
10 then, this sort of deals more with question 6, but I  
11 think your...your interactions with...with Duluth in  
12 terms of John Nichols and developing some of the more  
13 PDPK based approaches, I think I'd highly recommend  
14 that. I think you'll see perhaps some differences, and  
15 maybe that would, particularly with some of these  
16 compounds, we've already seen that you have some  
17 barrier issues with these...the gill membrane.

18                   Again, if we incorporate an oral  
19 exposure, then I think the multi-compartmental aspects  
20 become a little bit more relevant in those sort of  
21 situations. So, again, more futuristic, but, you know,  
22 something that you might want to look at.

23                   And, again, I think with the data that's  
24 coming out of the material range, that would be fairly  
25 critical in terms of plugging that in, perhaps, to your

1 particle size model. And I don't know how to do that  
2 in terms of the...the AGRO model but something that  
3 might be toyed around with in terms of just assuming a,  
4 you know, 1 DOC concentration but maybe tweaking that a  
5 little bit in terms of, you know, fines and...and even  
6 going below the fine concentration, whatever that is,  
7 in terms of what the...what the information is showing  
8 us.

9 We're seeing about 800 nm as being  
10 pretty critical in terms of the cutoff size in some of  
11 our studies anyway, but...so, let's see.

12 And, again, specific...I think the lipid  
13 issue is very important, particular in life stage  
14 issues and gender issues, particularly with male versus  
15 female spawning animals. I think that can have  
16 significant impact in terms of loading, retention in  
17 terms of accumulation, too.

18 I think that's something that...I don't  
19 know if that...I couldn't tell from the literature  
20 provided whether or not that's incorporated in the  
21 Gobas model or not in terms of gender or developmental  
22 stage in terms of...of lipid content, but I think  
23 that's something else that would be pretty interesting  
24 to sort of tweak around and...and play with and may at  
25 least reduce some uncertainty in terms of those high

1 KOW numbers.

2 So, that's about it.

3 **DR. HEERINGA:** Thank you, Dr. Schlenk.

4 We have about ten minutes before we break. Additional  
5 comments on either any of the discussants or other  
6 members of the panel on this particular...Dr. Hickie?

7 **DR. HICKIE:** Just one comment to follow  
8 up on the...the lipid issue when we run the Gobas model  
9 and...and other similar bioaccumulation models. Lipid  
10 content is...is put in as a fixed characteristic of a  
11 property. It's a dynamic biological thing, and so,  
12 you...I'm actually working on a paper right now where  
13 one fish species goes from 1.5 percent lipid in the  
14 spring to 9 percent in the fall, and PPD concentrations  
15 are constantly chasing towards trying to reach steady  
16 state, but they never catch up, because the lipid's  
17 always changing.

18 **DR. HEERINGA:** Dr. Norstrom?

19 **DR. NORSTROM:** Thanks, Brendan for doing  
20 a great job too.

21 I have a few comments here, mostly  
22 on...on this super-hydrophobic thing which...but also  
23 on the...on the whole use of log KOW. I sort entitled  
24 it kinetic considerations.

25 And for super-hydrophobic compounds, non

1 echoed in kinetics is definitely the rule, and we have  
2 to be really careful about using some of these models,  
3 I think, and just assuming that we can take these log  
4 KOW relationships and use them without any further  
5 thought. Too much reliance can be placed on them.

6           And...and my point, when I talked about  
7 this to Dr. Mackay a couple days ago, about the fact  
8 that we view log KOWs as ratios of concentrations when,  
9 in point of fact...or activities, if you like...they  
10 are actually also the ratio of rate constants  
11 between...transfer between media.

12           So, you could have two compounds that  
13 have similar log KOWs, but if they're solubility, for  
14 example, in... is relatively small, possibly the rate  
15 of transfer between the media might be slow in both  
16 directions where you get the same log KOW, but you get  
17 quite different kinetics or approach towards  
18 equilibrium.

19           And I'd like to sort of submit that we  
20 have a...a perfect example of that in...in the case of  
21 oxythiodibenzofuran which is not soluble, really, in  
22 anything that's non-aromatic, and in that case, you  
23 find that it transfers in the environment extremely  
24 poorly, essentially stays where it...where it goes,  
25 because it just simply doesn't move around very well,

1 from water, even though it has as log KOW which is, I  
2 believe, somewhere in the range of 8 to 9.

3 And that doesn't really model its  
4 kinetics in the environment at all. So, I think you  
5 have to consider, when you're looking at some of these  
6 pesticides, whether the solubility is itself rather  
7 small and...and worry about whether...if the kinetics  
8 might be affected as a consequence of that.

9 So, just relying on a constant like the  
10 log KOW may be a...a bit dangerous in some cases.

11 And I'd also like to point out that if  
12 you look at the log KOW dependence, for example, the  
13 bell curve that was shown yesterday on clearance rates  
14 in fish, the reason that those fall off at high log  
15 KOWs is because of internal kinetics in the organism.  
16 The rate of transfer to the gut and, therefore,  
17 partitioning into the gut contents as the mode of...of  
18 release is just simply inefficient, because the  
19 compound doesn't move from its storage site in the  
20 organism to the gut very efficiently, and so, it falls  
21 off.

22 And you have to be concerned, then,  
23 about that, too, because, you know, it is not a static  
24 situation. You have to consider there's a kinetic or a  
25 dynamic one.

1                   And remember, too, that even the fact  
2 that you have a log KOW dependence in the first place  
3 for a number of these parameters indicates it's a non  
4 equilibrium situation.

5                   And I'd just like to sort of use as an  
6 example the study by Catalan, et. al. there was a lake  
7 in the high mountain in the Pyranees, I believe, and  
8 they studied corranamids, terrestrial insects,  
9 mollusks, and anabacteria in trout. Used nitrogen  
10 stabilizer to determine trophic levels and definie the  
11 food web.

12                   And there, they showed that, in this  
13 case, organochlorines with log KOW higher than 6 showed  
14 lower concentrations in food than expected. So, non  
15 equilibrium, and they stated that distribution of  
16 compounds didn't reach equilibrium within the lifespan  
17 of the food organisms which was approximately a year,  
18 and in fish, however, only PCB-180 with a log KOW  
19 around 8 showed this kind of...this equilibrium thing.

20                   So, you know, I think you just have to  
21 be careful not to sort of assume everything is  
22 equilibrium kinetics and...and consider, especially for  
23 the high log KOW compounds. Equilibrium is seldom  
24 reached in...within or between compartments.

25                   I'd like to just briefly comment, too,

1 on the example that Brendan used of, I believe, it was  
2 the field polar bear comparison. That's a special  
3 case, I think, because marine mammals are quite  
4 different than terrestrial mammals in their metabolic  
5 capability. And it's possible, I think, that within  
6 the...in mammals, terrestrial mammals, possibly  
7 dividing it taxonomically more into sort of rodents or  
8 whatever...and undulates, you would probably find that  
9 there are at least similar type of metabolism there  
10 going on, if somewhat different rates come under the  
11 individual species.

12 I think that relationships could be  
13 developed which might be quite useful for this kind of  
14 thing. So, I don't...I think it would be worthwhile  
15 exploring, looking to see whether interspecies  
16 comparisons for other types of chemicals are...whether  
17 this is shown to be reasonably valid or not, and  
18 perhaps you can use, for example, lab...lab studies as  
19 a surrogate for a rabbit or something in a terrestrial  
20 ecosystem without...with reasonable security.

21 So, I think that's my comment. Thanks.

22 **DR. HEERINGA:** Thank you, Dr. Norstrom.  
23 Other comments at this point? Dr. DeLorme?

24 **DR. DELORME:** Just a...just a couple  
25 points that I don't think were...were covered already.

1 I have others that were already covered.

2 From a...for the modeling approach,  
3 I...I want to start by saying I like the sort of multi  
4 looking at several lines of evidence to look at this.  
5 I think that adds strength to your case in your...when  
6 you're doing this. It also will allow you to look at,  
7 you know, maybe when your models aren't working the way  
8 they are for a compound 4, you need to tweak them a  
9 little bit.

10 For the modeling approach, though, you  
11 could consider a tiered approach with respect to the  
12 complexity of the food web and receiving water  
13 scenario. For now, an initial tier 1 could be a simple  
14 food web like you used, standard farm pond, fixed  
15 inputs for certain parameters which allows for  
16 relatively quick implementation, you know, in the near  
17 term, you know, based on what you guys have already  
18 done.

19 I think you also have to be aware that  
20 you need to integrate, as Dr. Oris said, into the model  
21 structure any results with respect to resolution of the  
22 solubility issue, and also from Dr. Mackay's stuff, we  
23 saw that there was an impact of burial as well into the  
24 outflow.

25 So, when those issues are resolved, you

1 may want to look at...you need to have an integrated  
2 approach so that what you're doing in your...your fate  
3 modeling is also in your bioaccumulation modeling.  
4 Okay? They are all linked.

5                   As...as Dr. Oris pointed out as well, I  
6 think you need to consider regular development of  
7 additional data through either modification of existing  
8 study protocols or perhaps incorporating additional  
9 data requirements for PBT chemicals. That's going to  
10 help reduce your uncertainty, I think, in the long  
11 term.

12                   I think we're really dealing with a new  
13 paradigm here. We're moving away from, you know, the  
14 paradigm that we've used or the approaches we've used  
15 in the past for non-PBT chemicals into something that's  
16 a little bit different. We have to look at it a little  
17 bit differently.

18                   And in that respect, for chemicals that  
19 are subject to long-range transport, I think we need to  
20 recognize that there is a shift in risk both temporally  
21 and spatially. Okay? If you have something that's  
22 subject to long...long-range transport, you don't only  
23 have to be concerned about what's going on at the field  
24 scale which is sort of the typical thing that we've  
25 always done.

1 I think you have to look at what's going  
2 on elsewhere, you know, what's going on far afield and  
3 also temporally. I mean, you know that you're not  
4 going to see these things right away.

5 So, maybe what you want to do is, for a  
6 farm field assessment of new chemical when field data  
7 is not available, consider projecting a steady state  
8 future assessment if we can find a mechanism or a model  
9 to look at loading.

10 And you could use a simple approach  
11 where you just take your...your simple scenario, put  
12 your loading into it, and see what happens there.

13 **DR. HEERINGA:** Thank you, Dr. DeLorme.  
14 At this point, I guess I'd like to turn to EFED  
15 scientists to see if...if you feel this response has  
16 been comprehensive or whether there are points of  
17 clarification or questions you'd like to ask. Keith  
18 Sappington?

19 **MR. SAPPINGTON:** Well, I want to thank  
20 the panel for all the excellent suggestions. I think  
21 they're very insightful, and I appreciate them.

22 One question I have...and Dr. DeLorme  
23 talked about this with the tiered concept...is Dr.  
24 Hickie, with the recommendations of the different  
25 modifications to the food web models, if there's a way

1 to sort of triage those as ones that may be more  
2 important versus others, just because of the mode that  
3 we're in, and I...I...I think starting out with a tier  
4 1 and then moving to more complexes is probably  
5 something that we're very interested in. So,  
6 that's...that's one question.

7 **DR. HICKIE:** My main problem on that  
8 primarily had to do with adding the complexity of birds  
9 and mammals with...with the aquatic food web modeling.  
10 I...I think probably a lot of the issue there  
11 is...stems from what comes out of the EXAMS model in  
12 terms of exposure concentrations fluctuating over time,  
13 and I haven't quite wrapped my head around providing  
14 you advice right now on...on how to do it, but I  
15 can...I can certainly appreciate that keeping it simple  
16 on the first pass.

17 And...and...I think you could probably  
18 stick with a...an existing model at that first pass,  
19 but it's...it's...and it depends on where  
20 you're...you're working the things, you know, an  
21 example being water temperature. In some cases, it  
22 might be an issue; in some cases, it might not be and  
23 might have to deal with...with where the pesticide is  
24 being used. Is this...is it in a southern, warm  
25 location? Is it in a more northern state, or does it

1 have stronger seasonal fluctuations in temperature?

2 **DR. HEERINGA:** Dr. Norstrom, one  
3 additional comment?

4 **DR. NORSTROM:** It just occurred to me  
5 that, you know, if you're looking for something like  
6 a...a species that could be representing birds in a  
7 pond, you'd be hard pressed to find a better species  
8 than a great blue heron, because they're distributed  
9 widely everyone, and everybody knows that they even  
10 eat goldfish out of your own pond. So, you know,  
11 there...that would be fairly straightforward, I think,  
12 to sort of include a species like that as kind of a  
13 standard thing and would have some ecological realism.

14 **DR. HEERINGA:** Dr. Hickie?

15 **DR. HICKIE:** One thing you're certainly  
16 getting to with birds and mammals is...is the issue of  
17 home on the range, and there may be, you know,  
18 it's...and it...this also comes into play with  
19 the...with the aquatic versus terrestrial mixing.  
20 Birds such as a great blue heron might be feeding in  
21 multiple ponds and...and some might be predominantly  
22 aquaticly based in terms of their...their diet,  
23 and...and other ones may be a tremendous mix.

24 So, I...it...it...it's a difficult  
25 issue, and...and the home range issue, I think, is an

1 important one, and I've been addressing that with some  
2 mercury studies, looking at mercury in mink versus  
3 otters, and the home ranges vary tremendously.

4 **DR. HEERINGA:** Home range issues,  
5 obviously, come up in other modeling considerations  
6 like TIMS with the avian exposures and so, too. Dr.  
7 Meador and then Dr. Oris, and then we're going to take  
8 a break.

9 **DR. MEADOR:** Yeah, I was going to add to  
10 that, too. There's some great work by Chuck Henney  
11 with osprey from the Columbia River and river systems  
12 where you look at concentrations of plots in eggs, and  
13 they seem to be quite indicative of certain reaches  
14 where we...we seem to have a pretty narrow home range,  
15 like within a kilometer or so. Good indicator species.

16 **DR. HEERINGA:** Dr. Oris?

17 **DR. ORIS:** Yeah, if you're...if you're  
18 looking for tiered approaches, you know, it's been  
19 mentioned...and maybe I can try and...and summarize how  
20 I'm thinking about it. If...if the compound meets PBT  
21 requirements, then you might add a day requirement for  
22 a trophic transfer test in the laboratory. If that  
23 seems significant, then you may want to do more  
24 extensive modeling.

25 If the food web modeling, as...as

1 Brendan suggests, if you get a hazard quotient that's  
2 either well above or well below your level of concern,  
3 then maybe you don't need to go too much further with  
4 getting out of the actual water, but if it's close,  
5 then you might want to start looking at more dynamic  
6 models and the terrestrial connections with birds and  
7 mammals.

8                   So, there...there's ways to...to go at  
9 it more tiered without requiring, over requiring  
10 detail.

11                   **DR. HEERINGA:**       Okay, at this point, I'd  
12 like to thank everyone for their contributions on...on  
13 question number 4, and we'll have a chance again with  
14 follow-up. There's questions 5, 6, and others that  
15 deal with similar issues.

16                   But at this point in time, I'd like to  
17 call a break, and why don't we plan to reconvene at 10  
18 minutes to 11:00.

19 **(WHEREUPON,**    a brief recess was taken.)

20                   **DR. HEERINGA:**       Okay, if we can get  
21 underway, at this point...welcome back, everybody,  
22 first, and at this point, we have completed our initial  
23 discussions on charge questions 1 through 4, and we're  
24 ready to move on to question 5.

25                   Just a little forward thinking in terms

1 of schedule, it's not clear whether we'll be able to  
2 complete the charge questions today, and it's not my  
3 intent to rush this along that we do, but I think we're  
4 on a pace that we could potentially wrap up the  
5 discussion of the charge questions today, but if we  
6 need to carry over into the agenda tomorrow morning, of  
7 course, we'll do that, but I'll have a better sense of  
8 that by 2:00 or 3:00 p.m. this afternoon.

9                   So, let's...let's turn to charge  
10 question number 5, and, Dr. Brady, if you would, read  
11 that into the record for us, please.

12                   **DR. BRADY:**       Charge question number 5:  
13 The Agency currently assesses risks to terrestrial  
14 vertebrates that result from direct deposition of  
15 pesticides on food items that inhabit the treatment  
16 area. In general, this assessment is considered to  
17 provide relatively high-end estimates of excute...of  
18 acute exposure through the ingestion pathway.

19                   At this time, however, the Agency does  
20 not routinely assess pesticide bioaccumulation in  
21 terrestrial food webs in sites, in part, because the  
22 methods and tools for assessing bioaccumulation in  
23 terrestrial food webs are not as developed compared to  
24 those for aquatic food webs.

25                   Please comment on factors the Agency can

1 consider to identify when bioaccumulation potential in  
2 terrestrial food webs may be important to consider in  
3 its pesticide ecological risk assessment. Please  
4 comment on the current state of the science underlying  
5 existing terrestrial food web bioaccumulation models  
6 and their relative strengths and limitations.

7 **DR. HEERINGA:** Dr. Hickie is our lead  
8 discussant.

9 **DR. HICKIE:** And just...just before  
10 getting into it, I'd just like to comment that...that  
11 the original lead discussant was unable to make it,  
12 and...and I was asked at some point last week to take  
13 this on, and I...in hindsight, I kind of think I should  
14 have said no, since there are other people on the...in  
15 the group that I...I think are better suited to taking  
16 the lead. So, I'll have quite brief comments, and then  
17 I'll defer to them.

18 My co-discussants are Will Doucette,  
19 Randy Maddalena and...and Ross Norstrom, and it's a  
20 very nice blend of...Ross and I deal more on...on the  
21 sort of animal wildlife side, and Will and Randy  
22 are...are really well suited to talking to the...the  
23 soil/plant related issues.

24 To address the...can you move to the  
25 next slide, please?

1 To...to address the first of these  
2 questions, yes, KOA and KOW are important things  
3 in...in the decision or the formulation process of...of  
4 trying to decide when this should be looked at, and  
5 I...I started trying to think through, you know, what  
6 sort of break point in...in these values you would use  
7 for guidance, but I quickly came to the realization, a)  
8 that my knowledge was limited, and...and b) it depends  
9 on the situation, the...the scenario that you're  
10 working with, whether it's a near field, whether it's  
11 far field, and...and the mode of...or the input pathway  
12 of the pesticide into the system.

13 If it's coming in from the air, KOA is  
14 a...a...quite an important driver for accumulation into  
15 plants directly from air. If the pesticide is applied  
16 to the soil, then...then KOA is less important, but  
17 it...it's still a significant player, because the KOA  
18 defines chemical release back to...back to the air  
19 through the leaves.

20 And another thing there is if you're  
21 dealing with sort of off-site issues or...or areas any  
22 distance away from the pest...where the pesticide is  
23 being used, you also get into having to consider  
24 the...these chem properties that...that help you  
25 determine whether it's a long-range transport chemical.



1 So, that includes things like volatility, and, of  
2 course, you...the extent to which it's persistent in  
3 the air, things of that sort.

4 That...that's about what I have to say  
5 on...on the first question. Maybe I can defer to my  
6 colleagues that...that can perhaps...

7 **DR. HEERINGA:** Sure.

8 **DR. HICKIE:** ...add more.

9 **DR. HEERINGA:** Will Doucette is the  
10 first associate discussant.

11 **DR. DOUCETTE:** With regards to the  
12 physical chemical properties, I think...

13 **DR. HEERINGA:** Nearer the microphone.

14 **DR. DOUCETTE:** With regards to the  
15 physical chemical properties, I...I agree that KOA  
16 and...and KOW are important. However, it...and my  
17 emphasis has been on root uptake, and I think Randy's  
18 probably equally suited to deal with the...the air  
19 uptake issue.

20 We had a...a working group meeting  
21 on...and I'm going to specifically talk about the plant  
22 uptake. I'm going to stay within my...my comfort area  
23 on this and...and we...I mentioned yesterday that there  
24 were some more sophisticated models or, at least, newer  
25 models from the two listed in your table, and I think



1 that's true, and I passed the references on, so you  
2 should get those.

3           Stephan Trapp has got probably three or  
4 four iterations of the model that you have since there,  
5 and...and his approach now is...is really looking for  
6 specific scenarios of exposure, and I think once you  
7 guys decide on what an appropriate scenario is for  
8 looking at terrestrial fate which is something I think  
9 we'll also mention in the second question, then, I  
10 think, there will be models that you could actually  
11 use, and the input is relatively minor, at least on  
12 a...a tier 1 sort of thing.

13           And there are bioconcentration factors  
14 specifically for plants, and there is another parameter  
15 called a transpiration stream concentration. But the  
16 difference between plants and...and the fish that we  
17 talked about is it...it still is driven by the...the  
18 movement of the chemical through the root membrane, but  
19 it's...it's passively taken up and so that the amount  
20 that actually concentrates within the plant is  
21 proportional to the amount of water that's transpired  
22 by the plant.

23           So, the longer the exposure, the longer  
24 the water...or the more water that the plant transpires  
25 over time, the greater the potential concentration

1 buildup within the plant. And I think that's really  
2 kind of the state of the art where we know that fairly  
3 well.

4           What we don't know, necessarily, is  
5 the...the distribution within the plant. Generally,  
6 it...it tends to concentrate in the leaves. So, if you  
7 have an organism that is feeding on the leaves, that's  
8 where they're going to get the...the biggest dose.

9           And unlike fish species where, up to a  
10 certain level, the more hydrophobic it is, the greater  
11 the concentration in the fish, in plants, I think it's  
12 often...or it...it's still a little bit up for debate,  
13 but in general, it's the opposite, and the more water  
14 soluble the compound, the greater it is the chance it's  
15 coming from the roots, but the more hydrophobic, the  
16 greater the chance it is to come from...from aerial  
17 deposition.

18           And in our working group, we tried  
19 to...to simplify it. I had a...a working group on...on  
20 plant processes in...in England earlier...or late last  
21 year, and we used an arbitrary cutoff of about log KOW  
22 of 3.5. Anything greater than 3.5, we thought that  
23 atmospheric deposition was probably the most likely  
24 mechanism. Anything less than 3.5, we thought that  
25 root uptake was probably the...the most significant

1 mechanism.

2                   And for things that were very  
3 hydrophobic, we used a log KOW of, roughly, 5. That  
4 probably doesn't get into the plant at all from a root  
5 point of view unless it is a root crop like a...like a  
6 carrot or a potato. And that, you know, that was just  
7 trying to simplify things.

8                   And that's really where the state of the  
9 art is. There's a couple of...of good models or, at  
10 least, good conceptual models that have been...I won't  
11 say validated, but at least they've looked at a couple  
12 of small data sets to suggest that they have  
13 some...some foundation in reality, if you will, and I  
14 think those are probably usable.

15                   And that's really all my comments that I  
16 have.

17                   **DR. HEERINGA:**       Dr. Maddalena?

18                   **DR. MADDALENA:**    Okay, thank you. I...I  
19 agree KOW, KOA, and also reaction mechanisms are  
20 important indicators for terrestrial bioaccumulation,  
21 and I'll expand...I will expand it beyond my comfort  
22 zone here and go beyond education and look at  
23 terrestrial systems as a whole, and...and in that case,  
24 yeah, they are.

25                   And the main reason is

1 they're...they...they basically represent the  
2 solubilities in surrogates for pretty much the main  
3 parts of the environment. Lipids are represented by  
4 the octinol or vice versa, and you have water and air.  
5 So, these two partition coefficients really represent  
6 all three compartments in...in the real world or in the  
7 world we're trying to mimic.

8           So, by air, we're looking at these PBTs  
9 with really, really, really low vapor pressures. Well,  
10 it...it turns out that all the...you know, although  
11 things like the inhalation exposures may be exceedingly  
12 low because of low concentrations, the chemical mass in  
13 the air is likely to be one of the more dominating and  
14 most important processes for...for transport and mixing  
15 of these chemicals in the...in the environment.  
16 Certainly, movement in water is important as well, but  
17 as far as getting into the terrestrial system, the air  
18 is probably the biggest integrator of these chemicals.  
19 So, it has to be taken into account.

20           Therefore, that's why we...we recommend  
21 this KOA as an important indicator. And I think there  
22 are some indications that KOA also provides some  
23 understanding of fate inside the body as well inside  
24 the organism, but I haven't gone there. It is a simple  
25 and useful metric.

1 I'd like to extend this to a little bit  
2 in the recommendation, anyway, is to keep the...just  
3 kind of I like...it's important to look at these  
4 processes, these transport processes, in individual  
5 media and recognize that they...they really can't be  
6 decoupled for this particular class of chemicals. So,  
7 you can't just look at water, you can't just look at  
8 plant, and you can't just look at soil or air in  
9 isolation like you can for other chemicals.

10 So, there...there are important feedback  
11 loops that need to be captured, sediment to water to  
12 air, soil, biota. I'd even extend that to indoor air  
13 in the built environment. I'll say a little bit more  
14 about that later.

15 And this happens over very, very long  
16 time frames for this particular class of chemicals.  
17 So, it's...it's a different world, and I think I can't  
18 emphasize that enough, that...that these particular  
19 pollutants, the PB and LRT pollutants, ignoring the  
20 toxics for right now, are very different.

21 So, likewise, the kinetics...the kinetic  
22 constraints of mass transfer and transport for these  
23 chemicals is also important, because some of the biotic  
24 compartments, I think, as we've indicated in the  
25 aquatic system, may...their lifetime may not be long

1 enough to achieve any kind of steady state or even  
2 approach steady state.

3           So, the kinetics have to be incorporated  
4 into this. So, at least, you have to go to a...a level  
5 3 analysis if you want to use the fugacity type  
6 terminology that we talked about yesterday.

7           So, in short, although I think that the  
8 basic partition coefficients and degradation/metabolism  
9 rate are good indicators of terrestrial accumulation,  
10 I...I think it's important to consider these phys-chem  
11 properties in the context of a fully-coupled,  
12 multi-media mass balance model early on in the process  
13 before your problem formulations. These things are  
14 pretty easy to use.

15           So, recommendation is a tier 1  
16 assessment mainly to learn from the basic phys-chem  
17 properties that you're going to have on your table. A  
18 screening phase and in some cases, even a fate and  
19 exposure tool such as the level 3 mass balance models  
20 are...are relatively easy to parameterize, easy to use,  
21 and they're reasonably informative for things like  
22 developing a plan to move to more sophisticated  
23 modeling approaches.

24           And they're also informative along the  
25 way for interpreting things like PB and LRT. So, at a

1 minimum, these sort of so-called uni-world type models  
2 can provide insight into the approximate distribution  
3 of specific chemicals in the environment and...and,  
4 again, a first approximation.

5 I keep simplifying this, but it's...it's  
6 informative, but it's still a first approximation, but  
7 of how much of the mass that's applied in a given  
8 location, a given scenario, how much of that's going to  
9 be contributed to the global site, because different  
10 beast. You've got to think global on these chemicals.  
11 You can't think field at...at this point. You can  
12 start at the field, but you're going to have to go  
13 beyond that at some point.

14 So, that's my comments to 1.

15 **DR. HEERINGA:** Okay. Dr. Hickie, my  
16 interpretation is that you sort of split this question,  
17 or do you think that these comments addressed both  
18 parts of the question?

19 **DR. HICKIE:** They...they primarily  
20 address the...the...

21 **DR. HEERINGA:** First part?

22 **DR. HICKIE:** A good bit of the first  
23 part. I don't know if Dr. Norstrom has anything to  
24 add.

25 **DR. HEERINGA:** I'm sorry. Dr. Norstrom,



1 I...I cut you off. You are...

2 **DR. NORSTROM:** Yeah, I do. As far as  
3 the log KOW and log KOA thing, when I...I kind of  
4 looked at it from the standpoint of...of the Gobas  
5 models where inition through respiration is...is  
6 considered an important mechanism for compounds with  
7 low log KOA. I'm not sure how often you'll run into  
8 that kind of situation in pesticides but...

9 I'd like to point out that...that there  
10 may be some complexities there. We know that for some  
11 compounds...first of all, for compounds that have  
12 log...low log KOW, it's not always the case that...in  
13 terrestrial animals that...that 4 is the cutoff limit.  
14 There are numerous examples of compound with slightly  
15 lower log KOA than that that do, in fact, accumulate,  
16 although usually biomagnification factors are not very  
17 high, sometimes around 1 or a bit higher.

18 But there's...there's one compound  
19 that's fairly well studied, and that's beta HCH which,  
20 in fact, accumulates to quite high levels. BMS is  
21 very.. well quite high and in some mammals as well.  
22 And it has a log KOW of around 3.8, I think.

23 And in this particular case, the...the  
24 Gobas modeling tends to show it accumulating simply  
25 because the log KOA happens to be rather high. In

1 other words, the respiratory loss for this compound in  
2 organisms is...is rather low.

3           However, I'm concerned a little bit  
4 about whether this may, in fact, be a figment of...of  
5 metabolism, because most of these models are developed  
6 using chlorinated chemicals. So, the upper end in the  
7 regression is defined by compounds that basically don't  
8 metabolize very well, even in mammals and birds to some  
9 extent. You know, a lot of hexachloro and heptachloro  
10 PCBs have...basically, their mechanism of loss from  
11 higher organisms is by partitioning in the gut  
12 contents. Or in eggs or production of one kind or  
13 another, not metabolism.

14           Whereas at the lower end, most of the  
15 things probably are metabolized to some significant  
16 extent. So, the assumption in these models that the  
17 metabolism is not occurring can certainly affect the  
18 kind of interpretation that one wants to put on this.  
19 So, although I'm not at all ruling out the possibility  
20 that...that the interpretation that's put on by Gobas,  
21 for example, in 2003 where he did the... combination,  
22 Science 22 through 29, he says he derives a  
23 relationship with bioaccumulation log KOA for the life  
24 and care of a revoked food chain and came up with this  
25 interpretation of log KOA, but it assumed no

1 metabolism.

2                   And then, there's the Gobas paper that  
3 uses the soil and earthworms through food chain, and in  
4 that case, the maximum BMS that they're calculating is  
5 around 6 to 7 which is awfully low, I would say. So, I  
6 would say that metabolism certainly enters in there so  
7 that the...at least the relative importance of log KOA  
8 may be less than indicated and over-compensated for by  
9 metabolism.

10                   So, some caution should be used, I  
11 think, in the end proofing these models before they're  
12 taking as gospel as they stand. So, that's one  
13 comment.

14                   I'd also like to sort of come back to  
15 the...the whole issue of kinetic considerations within  
16 organisms in terms of bioaccumulation in...birds and  
17 mammals. A student of mine... showed that PCB  
18 congeners fell off exponentially approximately a factor  
19 of 10 between log KOW 5.7 and 7.8 for PCB congeners,  
20 and the 120-day uptake BMS increased by a similar  
21 factor but not a fall off in log...at high log KOW like  
22 you see in those bell shaped curves that were shown  
23 yesterday for fish.

24                   So, I think for mammals and birds, you  
25 tend to not have this kind of kinetic decrease at log

1 high KOW simply because they're higher temperature  
2 animals with bigger metabolic rates, and their  
3 distribution within the organism is therefore much more  
4 sort of at equilibrium.

5           Nonetheless, it's clear that the fact  
6 that we have a log KOW kind of shows that these are not  
7 equilibrium kinetics. You know, if it was purely  
8 active fugacity between the organism and gut contents,  
9 it wouldn't make any difference what the log KOW was.  
10 So, we have to be somewhat cautious about that.

11           I'm not aware of...of similar studies on  
12 clearance dependence of log KOW in mammals, but I think  
13 that, probably, they do exist.

14           I'd also like to just briefly at this  
15 point comment on the fact that you say that...that  
16 you're not sure that the methods and tools are  
17 developed. I think it's more going back to what Dr.  
18 Doucette said, that it's not so much that it's not  
19 possible to...to model terrestrial ecosystems. It's  
20 just that the mobility of animals and the complexities  
21 of their diets means that you have to define a scenario  
22 quite carefully in order to be able to do it, because  
23 once you do that, it's really not all that any more  
24 difficult to model in a terrestrial ecosystem than it  
25 is anywhere else.

1                   So, and some of the examples that, for  
2 example, that Dr. Gobas has used could be applicable in  
3 this particular case.

4                   I have some other comments, but I think  
5 they kind of more on...towards the second question.

6                   **DR. HEERINGA:**       Thank you, Dr. Norstrom.  
7 Dr. Maddalena?

8                   **DR. MADDALENA:**     Just to follow up on  
9 that, thanks. One other point in this phase of the  
10 assessment, early on in the assessment where I think  
11 this question about phys-chem properties comes in is  
12 the idea that often, if we have a simple model, we get  
13 the right answer for the wrong reason. And so, that  
14 really highlights the need to always incorporate a  
15 sensitivity analysis formally into your assessment  
16 process with these simple models, so you can understand  
17 not just what the model told you but why it told you  
18 that, and it will help you construct your assessment  
19 down the road.

20                  **DR. HEERINGA:**       Dr. Hickie?

21                  **DR. HICKIE:**       I'd just like to add in,  
22 and Dr. Norstrom can perhaps correct me, but since  
23 we're co-discussants, with...within a series of  
24 chemicals such as the PCBs, you...you can have a  
25 correlation between KOW and KOA. So, when you start



1 looking at bioaccumulation, it's...it may be difficult  
2 to...to sort out whether it's KOA or KOW  
3 that's...that's the main driver.

4 And...and traditionally, in modeling  
5 organisms, we've...we've always thought of it as being  
6 KOW.

7 **DR. NORSTROM:** Yeah, it's the old cause  
8 and effect thing, no question, although, actually, beta  
9 HCH does make a rather interesting example, because it  
10 falls off with KOW and KOA and happens also to be in a  
11 compound that it has a rather high BMS. So, there are  
12 enough exceptions to the rule that it may in fact turn  
13 out to be true that it...in other words, it's not just  
14 a kind of cross-correlation between the two that's  
15 causing that.

16 **DR. HEERINGA:** Dr. Thibodeaux, comment  
17 on this particular point?

18 **DR. THIBODEAUX:** Yes, I think my  
19 question is to Dr. Maddalena and Dr. Doucette.

20 On the tier 1 model which I assume is an  
21 equilibrium, if I understand you correctly, you said  
22 that because of the size of the species, tree or  
23 mammal, you're never at equilibrium. So, if you use an  
24 equilibrium model, then it's way out of bounds as far  
25 as predicting the concentration, even the organism.

1 Say if it was in air or even in ground water. Is that  
2 true?

3 **DR. HEERINGA:** Dr. Maddalena?

4 **DR. MADDALENA:** I think I would, for  
5 this particular class of chemicals, not go below a  
6 level 3 which is steady state, in which case you can  
7 have systems that don't...you can work in the death of  
8 the organism in the equation as far as mass transfer  
9 process say, example, from...from the air to the leaf  
10 to the soil becomes a mass transfer...or transport  
11 process, not necessarily what's accumulated in that  
12 leaf. It's what that leaf carries to the soil each  
13 year.

14 So, if your question was whether  
15 equilibrium models are appropriate, only as a very  
16 first real rough cut to see where things are moving to.

17 **DR. THIBODEAUX:** Yeah. So, level 3  
18 would be a steady state, if I remember right.  
19 Level...

20 **DR. MADDALENA:** Yeah.

21 **DR. THIBODEAUX:** ...4 is transit.

22 **DR. MADDALENA:** That would be dynamic.  
23 Yeah, that's my understanding of it.

24 **DR. THIBODEAUX:** In your opinion,  
25 what...if you do a steady state, then this begs the



1 question of transport coefficients, air to plants, air  
2 to...what's the state of that?

3 **DR. MADDALENA:** Development.

4 **DR. THIBODEAUX:** It's a loaded question.

5 **DR. MADDALENA:** I think they're fairly  
6 well evolved now and fairly well developed for this  
7 type of chemical. Again, you're talking very large  
8 spatial scale where you're averaging over regions.  
9 You're not averaging over a few meters in the bottom of  
10 a pond. So, you're talking very large deposition  
11 averaging over large spatial scales where the  
12 deposition may involve volatilization from surfaces,  
13 movement down into surfaces.

14 So, I think if you put it at that scale,  
15 it gets a little fuzzy, but the...the sophistication of  
16 the equations, I think, match the complexity of the  
17 question at this stage.

18 **DR. THIBODEAUX:** Can I follow on? What  
19 about trees and uptake from plants? Is...what's your  
20 perception of that? Kinetics, in other words.

21 **DR. MADDALENA:** There's...my perception  
22 of that in...based on the literature is that there's  
23 still some disagreement whether a tree can even reach  
24 steady state with these high KOA pollutants. Some work  
25 shows they do; some work shows they don't. So,

1 there's...I don't know how to quite answer that.

2 I know what equation I would put into  
3 the model, and I think those equations are pretty  
4 well...pretty readily available, and there's some  
5 consensus in the different groups that have looked at  
6 plant uptake as to their...

7 **DR. THIBODEAUX:** Well, that...that would  
8 become the question, and I agree with you, too.... but  
9 when you go there, you're going to need these  
10 parameters, seems to me, to be real. And I guess  
11 that's my question.

12 **DR. MADDALENA:** Bill...and Dr.  
13 Doucette...I...I get the sense that these parameters  
14 are...are...we can arrive at these parameters for a  
15 screening model from first principles with molecular  
16 weights and relating these various different chemicals  
17 in that sense, partition coefficients with...with  
18 various predictive models to get to them. So, I...I  
19 get the sense that these parameters to get to the  
20 transfer pathways and transfer factors are...are  
21 available, at least as a first cut.

22 **DR. HEERINGA:** Dr. Doucette?

23 **DR. DOUCETTE:** Whether to agree or  
24 disagree or where to, but I think part of it has to do  
25 with the...I'm still getting my...my head around

1 the...the conceptual model. I think from a...a global  
2 transport point of view and looking at persistence  
3 and...and bioconcentratable type chemicals, I think  
4 it's a little bit different issue kinetically than...at  
5 least in terms of plant uptake for...for other  
6 compounds.

7                   And my understanding...I realize we're  
8 supposed to be focused on...on those sorts of  
9 chemicals, but at least in terms of the terrestrial  
10 risk assessment, I don't think that that's done nearly  
11 in the detail that the aquatic risk assessment is done  
12 for...for not only the...the PBGs but, you know, just  
13 chemicals in general.

14                   And so, I'm still looking at it both  
15 ways. I'd like to see a...a scenario for...similar to  
16 the pond scenario for a short-range transport and then  
17 dealing with the question which I think a...a level 3  
18 model will probably deal with for long-range transport  
19 of the...the PBTs.

20                   So, I think it's almost, to me, separate  
21 issues based on the...the properties of the chemicals.  
22 I think kinetics are really important for more water  
23 soluble compounds, and it's a different set of kinetics  
24 that are important for the...for the more persistent  
25 compounds.

1                   Root uptake is important for...for polar  
2 compounds and not really important for really  
3 hydrophobic compounds. So, I think, you know, it's a  
4 little bit of both.

5                   And I...and I know we're supposed to be  
6 emphasizing the...the persistent  
7 bio...bioconcentratable sorts of things, the high log  
8 KOW stuff, but in terms of the level of complexity of  
9 the risk assessment, I don't think the terrestrial risk  
10 assessment is anywhere near as...as well developed as  
11 the aquatic, and I would think that that would also be  
12 of...of interest to have an approach that would deal  
13 with...with all classes of...of chemicals over a wide  
14 range of hydrophobicities.

15                   I don't know. Maybe I'm wrong there.  
16 And it doesn't seem like the...the terrestrial  
17 assessment is...is very sophisticated relative to the  
18 aquatic assessment for any type of chemical.

19                   **DR. THIBODEAUX:** All right, I second  
20 that. I...and I liked your comment about short range,  
21 near the application rather than long range which is,  
22 to me, alpine and arctic. Thanks.

23                   **DR. HEERINGA:** Dr. Norstrom?

24                   **DR. NORSTROM:** I think, actually,  
25 my...my...one of my comments here probably fits in this

1 category. When we're talking about emphasis of KOA and  
2 KOW and...and various things like that, basically,  
3 we're talking about partitioning in the environment.  
4 When we...when we talk about leaves and plants and  
5 whatever, that's great, but when you get into the  
6 organism, you can't over-emphasize the importance of  
7 metabolism.

8                   So, much of this whole area in the  
9 aquatic system is...is derived from models that are  
10 developed on persistent compounds that, basically,  
11 aren't metabolized by anything in the system, and once  
12 you get into the terrestrial environment, right away,  
13 that completely breaks down, because practically  
14 everything is metabolized.

15                   If you look at the kind of taxonomic  
16 development of enzyme systems, terrestrial animals,  
17 basically, are exposed to a much wider variety of  
18 compounds than marine ones. So, as the difference  
19 between a whale, for example, and a cow, they're very  
20 different in their metabolic capabilities, as one is  
21 exposed to very different things than the other.

22                   So, most of the compounds that we're  
23 talking about here are likely to be metabolized by  
24 terrestrial mammals, and there...it's...so, you...the  
25 actual accumulation, the dose and exposure and so on,

1 of course, can be modeled with these types of  
2 parameters, but in terms of...of passing them on within  
3 a food web or long term kind of whole body  
4 concentrations within an organism that's exposed to  
5 something directly in the physical environment cannot  
6 be done without consideration of metabolism. It simply  
7 can't.

8                   So, that's important, I think, to...to  
9 remember that there are differences there.

10                   And I mentioned before that I think that  
11 there may be some surrogates that could be used. Types  
12 of metabolism don't vary that much among taxa.

13                   You can see birds and mammals all  
14 metabolize the...the same PCB congeners, roughly, with  
15 the same structure activity rules at slightly different  
16 rates, but they pretty much all do the same thing.  
17 Whether that's true for all chemicals is...is  
18 debatable.

19                   But I think with suitable kind of  
20 investigations, what's...what is out there in the  
21 literature you might be able to come up with  
22 some...with some fairly general rules for that so that  
23 if you have clearance rates, for example, in a  
24 laboratory animal, you might be able to extrapolate  
25 that to a wild mammal but...or a bird of some sort as

1 as a first approximation, at least.

2           And then, for the compounds that are not  
3 metabolized, we have, actually, some quite good data  
4 now for size-specific clearance and that kind of thing  
5 which could be used. One example that I've used is  
6 pulling together some literature by Glazier and  
7 Connelly where they show that the clearance rates of  
8 DDE which is essentially not metabolized in birds is  
9 basically cleared as a function of body weight to the  
10 minus 0.3. So, those kinds of allometric relationships  
11 can often be used for both exposure as well as  
12 clearance.

13           Thanks.

14           **DR. HEERINGA:**       Thank you, Dr. Norstrom.  
15 Dr. Hickie, I think I'd like to move on to the second  
16 part of this. Well, Dr. Biddleman has a...

17           **DR. BIDDLEMAN:**     Before we leave this  
18 part, I wanted to address the...feedback...I wanted to  
19 address the problem of accumulation in plants and that  
20 the higher KOA chemicals only accumulate by atmospheric  
21 deposition on...on the leaf surface.

22           There have been several experiments done  
23 that shows that certain plants, the cucumber type, the  
24 cucurbits, for one, but other plants as well, take up  
25 substantial quantities of hydrophobic chemicals through

1 their roots and translocate them within the plant.  
2 The...the papers I'm looking at right now are done by  
3 Mary Jane Matina from Connecticut Agricultural Research  
4 Station. Shes' been working for many, many years in  
5 this area. It's not only cucurbits. It's other plants  
6 as well.

7           And there seems to be specific transport  
8 mechanisms that are going on with...within the sap of  
9 the plant. They're even an ancio selective. So...so,  
10 there's definitely, you know, discrimination pathways  
11 that are going on with transport.

12           One of the chemicals that she was using  
13 was chlordan which is a KO...KOW of about 6. So, it's  
14 a pretty hydrophobic chemical, and yet, this is  
15 translocated throughout the plant.

16           So, it may be a bit simplistic to think  
17 that...that all the accumulation in plants goes on  
18 through atmospheric deposition to the leaves. I...I  
19 don't know how this relates to other plants that you  
20 might find out in the wild like grasses or...or...or  
21 trees or something like that. I mean, maybe the only  
22 relevance is to the deer eating my garden vegetables,  
23 but I think it's something to think about, and I  
24 wondered what...what Bill thought about this. Bill,  
25 you...

1                   **DR. DOUCETTE:**       And Jason White, too, and  
2 we've had lots of discussions, and...and that is an  
3 interesting issue to bring up, and they certainly have  
4 shown some potential for those compounds to go up.  
5 Right now, though, in terms of, you know, how widely  
6 applicable that is, it doesn't seem to be very widely  
7 applicable other than to, you know, those sorts of...of  
8 plant species.

9                   So, you know, I think some of the other  
10 generalizations probably still work for...for most  
11 plant species, and I don't think even that group truly  
12 understands why those compounds go up. And if...if you  
13 start looking at the calculations, the mass in the  
14 fruit on a dry weight basis, it's still relatively  
15 small to...to the potential of...of atmospheric  
16 deposition on...on most leaf surfaces.

17                   So, I...you know, it's an interesting  
18 issue. It's just really the state of the art in plant  
19 uptake through roots is not nearly as well developed as  
20 it is for...for fish and...and, you know, mammalian  
21 species. So...but it's interesting.

22                   **DR. HEERINGA:**       Dr. Norstrom, one  
23 additional comment, and then I do want to move on.

24                   **DR. NORSTROM:**       I had just an additional  
25 comment about...about cucurbits, because as far as I

1 know, watermelon, for example, can even be shown to  
2 take up viruses. So, the...the water flow through the  
3 root system, to some extent, is just gigantic when  
4 they're growing, and, possibly, it just gets kind of  
5 carried along with it, but that wouldn't be generally  
6 applicable for most plants anyway.

7 **DR. HEERINGA:** Dr. Hickie, let's move to  
8 the second part of the question.

9 **DR. HICKIE:** Next slide. You can...this  
10 is my only next slide, so you can see I...I spent far  
11 more time on preparing the aquatic part of this.

12 So, this part of the question now goes  
13 to comment on the current state of the science, and  
14 I...I think the discussion has already gone in that  
15 direction to a good extent.

16 But I think the way we...we saw this  
17 issue and...and sort of way of moving forward is...is  
18 we really have two distinctly different issues or...or  
19 we could consider that the overall model as having two  
20 distinctly different sub-units, and one...one being the  
21 lower box there, air, soil, plants, and so, as well, in  
22 organisms where the inputs into that can either be from  
23 the air going into the plants or...or air to...to soil  
24 deposition by various means or...or direct  
25 applications.

1           So, that's different input pathways, and  
2 as I understand it right now, EPA methods don't...don't  
3 have a way of addressing atmospheric inputs in the  
4 current modeling approaches other than spray drift.

5           Within that model, I...I think there  
6 would be a need to address different plant species. I  
7 think Dr. Doucette can comment on this. There's  
8 connections with phyto-remediation where some plants  
9 are extraordinarily good at accumulating certain  
10 contaminants from soils.

11           Another important factor is...is, of  
12 course, in the...in the connection to herbivores, is  
13 herbivores eat different parts of plants. Some would  
14 eat the foliage, the fruits, the seeds. So,  
15 there...there's also a modeling need to be able to  
16 compartmentalize the...the plants to take this into  
17 account.

18           Moving up to the second sub-unit is...is  
19 sort of above ground, we get into birds and mammals  
20 where you have both herbivores and...and carnivores,  
21 and...and a number of things that...to think of here is  
22 in some cases, just modeling an individual species such  
23 as an herbivore might...might be sufficient, and that  
24 might be done on a...on a very simple sort of first  
25 pass approach to see if they perhaps are accumulating

1 some significant amount.

2 If...if they are, then you might want to  
3 follow that up with a...a carnivore. So, some degree  
4 of flexibility here is...is important.

5 Generally, aquatic...or terrestrial food  
6 chains are...are short in length relative to aquatic  
7 systems. Dr. Norstrom touched on this earlier, I  
8 believe. But a challenge is...is that their diet can  
9 be quite variable, and this...this is a challenge to  
10 address.

11 And it's something that the two example  
12 papers from Gobas' group didn't really get into. They  
13 have very simple food chain, lichen, caribou, wolf, and  
14 in the case of lichen, the lichen really have no  
15 interaction with the soil. It's just direct  
16 atmospheric uptake into caribou, and...and they also  
17 consider that wolves are only eating caribou, and I'm  
18 not too sure about the validity of that assumption. I  
19 imagine they eat other things. They're awfully  
20 opportunistic.

21 Another real challenge with the issue of  
22 birds and mammals beyond just simply choosing example  
23 species to work with is trying to come up with generic  
24 food chains that...that might be representative of  
25 continental United States. I...I...I don't think...or

1 I certainly couldn't think of, you know, an example  
2 that would...that would be widely applicable  
3 like...like we have with the...the aquatic models.

4 Another aspect in there...and I  
5 mentioned this earlier...is...is you have this  
6 cross-over between terrestrial and aquatic food webs  
7 when you're dealing with birds and mammals and...and  
8 the issue of home range.

9 With that, I think I'd like to turn over  
10 to my esteemed colleagues.

11 **DR. HEERINGA:** Yes, we'll go to Will  
12 Doucette first.

13 **DR. HICKIE:** Yes.

14 **DR. DOUCETTE:** Let's see, where to  
15 start. I guess I'm going to stick to what I feel most  
16 comfortable with in terms of...of the plant uptake, and  
17 I...I think I'll just reiterate my comments before.

18 There are some more models that...that  
19 might be able to be used in a...in a...a screening  
20 level sort of assessment. I'm still more comfortable  
21 with the idea of...of two levels of models, one of  
22 a...a short range and then another long range, almost  
23 analogous to what...what's done now for the...the  
24 aquatic system.

25 And I think, right now, in terms of...of

1 plant uptake, there's a lot of different literature,  
2 and there's some...some consensus starting to develop,  
3 but there are no standard methods for generating plant  
4 uptake data, and if you start looking at...at all the  
5 literature information on plant uptake, it's...it's  
6 very scattered.

7           And until there's a...and I wrote this  
8 in a paper recently...until there's a regulatory driver  
9 to...to require the...the development of plant uptake  
10 on a...data on a consistent basis, I don't know that  
11 the state of the art in terms of predictability is...is  
12 going to improve very rapidly.

13           And so, that, you know, that's just kind  
14 of a limitation. There's no big driver to generate  
15 plant uptake data. There used to be a lot of plant  
16 uptake data from the...the pesticide groups early on,  
17 but it wasn't...it wasn't shared, and there's just not  
18 a lot of...of good, solid...solid literature data.

19           But I think Stephan Trapp, some of his  
20 initial models would be good screening level, at least  
21 for getting it up into the...the plant and deciding if  
22 that's actually important, and I think the atmospheric  
23 deposition models are probably a little bit more well  
24 developed for predicting what concentrations might be  
25 on leaf surfaces coming from atmospheric deposition

1 from the more hydrophobic compounds. And you might be  
2 able to correct me if...if I'm wrong there.

3 And I...I guess that's where I'll quit.  
4 I...I think it's appropriate to have a short term  
5 transport scenario and then the...the long term and  
6 then kind of build from there.

7 And, oh, one other comment. Metabolism  
8 is also important in plants. We talked about it  
9 in...in terms of mammalian species and fish, but it  
10 also happens in plants, and the...then enzyme system  
11 very similar. So...and that's something there's not a  
12 lot of information on, but it's also a consideration.

13 **DR. HEERINGA:** Dr. Maddalena?

14 **DR. MADDALENA:** Okay, I'm going to, once  
15 again, approach this in just a slightly  
16 different...from a little different direction. I'll  
17 try and answer the question you asked but in a little  
18 different way.

19 So, if we put this question in the  
20 context of overall uncertainty...sorry, I'm just going  
21 to kind of read through my notes so I don't get to  
22 rambling too far. That's all the rambling I'll do.

23 So, if we just...if we put this question  
24 into context of...of really overall uncertainty in the  
25 assessment that you're dealing with which, I think, is

1 quite high, and I think most would agree it's still  
2 quite high, I would conclude that the existing  
3 terrestrial assessment tools are fairly well developed.  
4 Certainly, that depends on how much resolution, both  
5 temporal and spatial, you want to put into your  
6 assessment, but for the chemicals with PBT  
7 characteristics, it may be okay to accept a fair amount  
8 of less spatial and temporal resolution in exchange for  
9 much broader coverage for the assessment, and this  
10 particular class of chemicals, I think, warrants a  
11 broader coverage in both space and time.

12                   So, let's just assume we believe  
13 that...that the tools, algorithms, equations that  
14 describe these processes, that it fits as to fate of  
15 terrest...the terrestrial fate of chemicals are  
16 available, and assume they're adequate for the crops  
17 anyway, then the question really shifts to whether or  
18 not you've identified the...the best use of these tools  
19 for this particular application.

20                   And based on what I saw in the...in the  
21 white paper and the presentations on it, I'm not sure  
22 that the conceptual model has been fully developed yet  
23 for PBT type chemicals, at least in the terrestrial  
24 environment. And I'll give a few examples, and then  
25 I'll...I'll give you some suggestions, at least, what I

1 think some reasonable suggestions would be.

2           The first example is with spatial scale.  
3 So, the current OPP approach to the terrestrial fate  
4 seems to be primarily focused on near-field  
5 accumulation of pesticide, exception being this...this  
6 screening of long-range transport. But the assumption  
7 is that...that this is going to...the way I understand  
8 it, the assumption is that will represent a...the  
9 highest ecological exposure.

10           Well, this may be true if...if, in fact,  
11 the vulnerable organisms or habitat happen to be near  
12 the treatment area, the agricultural region that's  
13 treated with whatever pesticide is being registered,  
14 but for PB and LRT chemicals, we shouldn't be surprised  
15 to find them in places that we didn't use them, and I  
16 think that's a lesson that was a hard-learned lesson,  
17 and I don't think it should be forgotten, that they do  
18 move around even if they just don't seem to have a  
19 vapor pressure. They're going to go places.

20           So, really, you can probably provide  
21 adequate spatial scale in your conceptual model, and  
22 the assessment that captures these unique...and I  
23 quote...hazards, because they're not hazards in the  
24 classic toxicology sense, but it...the exposure hazards  
25 certainly exist for this particular class of chemicals.

1           So, a second example would be temporal  
2 scale. So, another aspect of the conceptual model is  
3 the...the time frame of the assessment, and for this  
4 particular...again, this class of chemicals, the scale  
5 needs to be quite large. It can't really focus on a  
6 growing season necessarily. It's got to focus on a lot  
7 longer.

8           So, although the resolution is also  
9 important and should be built into the assessment, I  
10 think that, for this particular class of compound, we  
11 should first make sure that we use an overall duration  
12 that is adequate to capture long-term behavior of the  
13 chemicals, both during and after use, in other words, a  
14 full life cycle of these...these chemicals.

15           And this life cycle view of the  
16 assessment requires an understanding of the possible  
17 use patterns for a given chemical, and I don't know if  
18 that goes into your current decision making process,  
19 but it...I think it's going to be important for PBTs.

20           o, in other words, for this group of  
21 chemicals...and I keep focusing on this, because you've  
22 got a long history of doing it right for other  
23 chemicals...I think it's very important to understand  
24 not only the recommended application practice, i.e.,  
25 pounds per acre, things that you classically look at,

1 but also the anticipated aerial coverage. And I tried  
2 to bring this question up yesterday. And the primary  
3 regions where this stuff is going to be used, because  
4 that's going to impact your global contribution to the  
5 mass balance.

6           A third point would be transport  
7 processes. So, given a high overall persistence and  
8 mobility of these chemicals, it's going to be important  
9 that the conceptual model include a characterization of  
10 feedback pathways that control the long-term mass  
11 balance, not necessarily near field, but long-term mass  
12 balance on a larger scale.

13           And there's a lot of low-hanging fruit,  
14 I think, in this area for characterizing transport and  
15 transformation processes, at least at the level of  
16 detail that is needed for these chemicals. So, from  
17 this information and from the presentations yesterday  
18 and the conversation this morning, we can go to great  
19 detail about mass transfer into a plant from the roots  
20 into a cucumber, specific varieties of cucumbers in a  
21 specific garden and then try and build this all up,  
22 and...and it's really easy to get lost. And I'm not  
23 suggesting that.

24           What I'm suggesting is understanding  
25 the...the...the primary pathways. For example, rather

1 than look at plant uptake, we may be satisfied with the  
2 moving air mass over a forest canopy and looking at  
3 that interaction. So, larger scale stuff.

4 And understanding primary compartments  
5 in the system, air, water, soil, sediment, vegetation,  
6 should be a high priority, because I think it then can  
7 control the mass balance, and then, the things that  
8 contribute to exposure, like uptake into a specific  
9 food chain or a plant or an animal, can be plugged into  
10 this mass balance at a later point.

11 And that brings me to the...the endpoint  
12 or the receptor that you've got included in your  
13 conceptual model. The current model right now,  
14 recognizing that OPP is somewhat constrained by  
15 these...these classic definitions of ecosystems where  
16 plants and animals are the only thing you can look  
17 at...and I...I'm not from the regulatory side, so I  
18 don't understand the institutional expertise or turf  
19 that needs to be respected, but for this particular  
20 class of chemicals, I think it's essential that you  
21 include human exposures in your assessment, even on the  
22 effect side.

23 I'm not saying take up human health risk  
24 assessment, but you've got to include the consideration  
25 of humans in your conceptual model. In fact, human

1 exposures may dominate the final outcome of any  
2 assessment you do, so that's got to be considered when  
3 you're putting together your terrestrial food chain,  
4 that you understand what it's feeding into, I think.

5           So, for example, considering uptake and  
6 accumulation into vegetation, understanding exposure  
7 concentrations for target plants and terrestrial  
8 animals may important and, you know, and likely will be  
9 important, but looking at the uptake pathways as a way  
10 to get tox into the food chain may be adjusted for.

11           And the good news is that could simplify  
12 your assessment. The detail may be able to be reduced  
13 a little bit.

14           So...so, you've got the approach. Early  
15 on or the last question, I said a tier 1 approach might  
16 be these mass balance models, simple...relatively  
17 simple, uni-world steady state, but once the overall  
18 conceptual model is established, it may not be  
19 necessary to develop new modeling tools from scratch.  
20 I think these models are available and of sufficient  
21 detail for the lower tier assessment if not even higher  
22 tier assessments.

23           One example would be a better  
24 model...and I can give you a citation...but this, to  
25 give you a sense of what the kind of scale I'm thinking

1 about, this particular model provides a continental  
2 scale, dynamic, level 3 or level 4, a mass balance  
3 model that compose...it's composed of eco-regions. So,  
4 you can actually put applications in certain places and  
5 see how that contributes to exposures in other places.  
6 It's got some eco, very low-level detail, eco and human  
7 exposure in there, and it also has some food transport,  
8 movement of food products, through out the...the  
9 continent.

10 And another example that I brought up  
11 yesterday was this TRIMFATE model, and that could take  
12 you to even another level of complexity, because it  
13 allows you to construct your polygons in a way that  
14 represents a real site and go to as big or small of  
15 detail that you want. Again, don't get overwhelmed  
16 with complexity there, because I don't think it's  
17 necessary.

18 But, ultimately, one of the biggest  
19 concerns that's going to drive these decisions...and  
20 it's a hard decision when you deal with these types of  
21 chemicals...the biggest concern is how long is it going  
22 to take to show up in human tissue? And we're  
23 measuring human tissues all the time, and every time a  
24 new one shows up, it...it's like well, how did that  
25 happen?

1                   So, these decisions being made now are  
2 going to be really challenging. So, I think you've got  
3 to look at the broader picture on fate and not just a  
4 near term or a near...near field like has worked  
5 classically for these chemicals.

6                   So, sorry to be so long-winded, but  
7 that's...

8                   **DR. HEERINGA:**       Very helpful. Thank you,  
9 Dr. Maddalena. Dr. Norstrom, and I won't forget you  
10 this time.

11                  **DR. NORSTROM:**       Yes, I'd like to  
12 reemphasize that it's not...from the standpoint of...of  
13 birds and mammals, it's not so difficult, once you know  
14 what the exposure is, to do the rest of it.  
15 It's...it's a problem of deter...determining your  
16 scenario, so following upon Dr. Maddalena's comments,  
17 it really is important to develop some hard and fast  
18 kind of scenarios that...that can be, you know, if you  
19 need the sort of terrestrial ecosystem that...that's  
20 sort of like a standard ponds.

21                  In other words, if you're going to do  
22 local term things or if you're going to take it further  
23 afield, then the models exist to do that, but you need  
24 to define it in some fashion or another so that you can  
25 then say okay, you know, bird or mammal X and Y

1 are...are eating this particular thing. Otherwise, it  
2 just gets to be hopeless.

3 So, it's not that it's not possible to  
4 do. It just needs to be well defined.

5 One of the things that...that...that  
6 occurred to me while I was just sitting here thinking  
7 about it, I was thinking about a colleague...former  
8 colleague of mine, Dr. Surei Betat who works on agro  
9 ecosystems and...and biodiversity on the borders of  
10 agricultural plots.

11 And it occurs to me that this is  
12 something we haven't talked about. I don't know  
13 whether it's part of...of what you're pursuing here or  
14 not, but the effect not so much on bioaccumulation,  
15 but, for example, if you're moving a particular animal  
16 from an ecosystem in terms of food supply and the  
17 effect of that on...on the predator of that, is that  
18 something that EPA is...could, at least theoretically,  
19 consider including in this kind of a...of a system?

20 **DR. HEERINGA:** Dr. Bradbury?

21 **DR. BRADBURY:** The...yes, and we're  
22 doing a little bit of reductionism here so that we can  
23 kind of focus on the questions we have here which is  
24 essentially trying to get a handle on how, with the  
25 right temporal and spatial scale, to predict or

1 estimate what the risk could be to chemical...to direct  
2 effect of the chemicals on identified species.

3           And in other parts of our program, we  
4 are working on population modeling and taking a look at  
5 the community level effects, and we are looking at what  
6 we call the indirect effects. You know, a certain part  
7 of the habitat is in a different state. What kind of  
8 ripple effect may that have on...on different trophic  
9 levels.

10           So, we are working on that. We didn't  
11 bring that up in this SAP to try to keep focused on the  
12 question at hand.

13           **DR. NORSTROM:**       Okay, thanks. I have,  
14 well I, just, I think, really one other comment here,  
15 and that is we know now, from some of the surprising  
16 results that have been found, for example, the  
17 chlorinated compounds but other...other types of things  
18 that I'm more familiar with, for example, persistence  
19 of hydroxy PCBs and strange things like that that were  
20 not suspected. We have to think outside the box, I  
21 think, sometimes when we're dealing with new classes of  
22 chemicals in terms of what actually determines  
23 persistence. So, it's kind of going back to the  
24 KOA/KOW thing.

25           In the case of chlorinated compounds in

1 higher organisms, it turns out that probably  
2 angio-hepatic circulation is kind of trying to get  
3 trapped in that kind of thing. So, they persist, not  
4 because they have a high log KOW, but they're mimicking  
5 bio acids.

6 And protein, specific protein binding,  
7 for example, is responsible for things like phenolic  
8 compounds being caught in plasma and...and liver. So,  
9 you have to consider this in addition to kind of  
10 traditional type of partitioning mechanisms that...that  
11 we've been considering here.

12 Probably for everybody in this room, the  
13 second or third highest foreign chemical circulating in  
14 your body is pentachlorophenol. It's extremely  
15 persistent, because it binds to thyroid transport  
16 protein, and even though levels in the human food chain  
17 are rather low, it's actually quite persistent in  
18 blood.

19 So, those kinds of surprises are coming  
20 up all the time, and we need to be aware that we can't  
21 just look on it as a simple partitioning process,  
22 especially for new chemicals, as there could be some  
23 big surprises.

24 Thanks.

25 **DR. HEERINGA:** Thank you, Dr. Norstrom.

1 Additional comments on question number 5 from panel  
2 members? Dr. Biddleman?

3 **DR. BIDLEMAN:** I...I don't know if this  
4 falls within the purview of your...of your panel or  
5 sub-panel. It's not really a bioaccumulation  
6 mechanism, but I wondered if...if you've considered  
7 the...the special exposure of...of birds and other  
8 animals picking up the pesticide directly, like  
9 ingesting granules, micro-encapsulated pesticides,  
10 treated seed, et cetera. Is this...probably a  
11 near-field effect, but is it...is it something the  
12 bioaccumulation group has been discussing?

13 **MR. ANDERSON:** Brian Anderson. We...we  
14 do directly evaluate potential risks to birds and  
15 mammals that consume granules and...and treated seed.

16 **DR. HEERINGA:** The SAP, Dr. Bidleman,  
17 has had a number of sessions on models for avian  
18 exposure...

19 **DR. BIDLEMAN:** Oh, okay, okay.

20 **DR. HEERINGA:** ...and risk but an active  
21 program there, and, actually, it's part of the most  
22 recent carbofuran review. There was a very extensive  
23 set of deliberations on the avian exposure part, both  
24 on field and near field.

25 **DR. BIDLEMAN:** So, it's...it's covered

1 elsewhere. Okay. Thank you.

2 **DR. HEERINGA:** In fact, it's very much  
3 covered elsewhere. My impression is there's a lot of  
4 activity in that area, at least, a lot of focus.

5 Dr. Oris?

6 **DR. ORIS:** For the terrestrial  
7 bioaccumulation and, to a certain extent, for higher  
8 trophic levels coming out of aquatic ecosystems, for  
9 these chemicals, I think you...you need to be prepared  
10 to look at multiple compartment modeling, and...and  
11 there's two reasons for that.

12 The first is that, similar to what Dr.  
13 Hickie said about selected feeding on...on plants by  
14 higher trophic level organisms, carnivores also are  
15 selective feeders. So, you might need to know what the  
16 dose coming out of the liver is for...from fish into  
17 birds or from other mammals, from one mammal to another  
18 mammal.

19 And especially in times when there's  
20 seasonal times of over-abundance like during spawning  
21 runs for fish. The birds go after the hide. Bears eat  
22 the liver and then leave the rest behind. And so,  
23 they're targeting specific organs, and so, you really  
24 need to be careful about what compartments you're using  
25 to estimate dose for transfer.

1           The other reason to...to do that is to  
2 consider storage compartments. These chemicals aren't  
3 going to be uniformly distributed throughout the...the  
4 organism, and so, if there's a...an organ of storage  
5 and those storage compartments change seasonally or  
6 temporally or with life stage, then you need to  
7 consider what happens as those change.

8           So, be prepared to need to go more  
9 complex with your bioaccumulation models and do  
10 multiple compartments or PBPK type model.

11           **DR. HEERINGA:**       Dr. DeLorme?

12           **DR. DELORME:**       One of the dangers of  
13 sitting around with people at night is you get ideas in  
14 your head, and, certainly, Dr. Maddalena last night, we  
15 had some discussion, and he brought up the...the human  
16 aspect.

17           You know, terrestrial organisms can  
18 potentially be the ultimate recep...receptor, at least  
19 maybe from the risk manager's perspective. There is a  
20 link between potential bioaccumulation and environment  
21 in humans.

22           I was just wondering, is there anything  
23 you can borrow from human health risk assessments to  
24 aid in the modeling of your assessment of  
25 bioaccumulation in wildlife? Certainly, there's data

1 and studies that we already use.

2           There may be additional things that we  
3 can look up, such as residue trials or metabolism that  
4 can help in...in bioaccumulation modeling. You might  
5 want to explore if any of their models are useful as  
6 well. Can they be adapted to a...to a wildlife  
7 situation?

8           For far afield, long-range transport,  
9 things like Dr. Bidleman here keeps on pulling up  
10 articles. He did pull up an article by Zibb, et. al.  
11 which was published in 2008 in the SAP looking at  
12 bioaccumulation in humans in the arctic resulting from  
13 long-range transport. You want...might want to take a  
14 look at that, because it includes wildlife in it.

15           And the other thing that occurs to me,  
16 is there information with respect to simple terrestrial  
17 food web structure or modeling from Superfund  
18 assessments that might be adaptable to your...your  
19 stuff?

20           **DR. HEERINGA:**       I'll turn to...to Dr. Ray  
21 and Brian Anderson to ask whether you feel the panel  
22 has addressed this topic. Do you have any...Khristina?

23           **MS. GARBER:**       I have no questions.

24           **MR. ANDERSON:**       We have one right here.

25           **DR. HEERINGA:**       Dr. Bradbury?

1                   **DR. BRADBURY:**       Switch my hats around.  
2 I.. I really enjoyed the...the discussion about spatial  
3 scale and temporal scale, and I tried to bring that up  
4 in my opening remarks about, you know, the classic  
5 scenarios that come up really doesn't have  
6 bioaccumulation potential and low use of qualitative  
7 words. It tends to be great.

8                   So, quickly and both from a spatial and  
9 temporal point of view, you start thinking close to the  
10 field, short time frame, and you move into greater  
11 persistence, higher bioaccumulation potential, and more  
12 and more in the next charge question, too, about  
13 long-range transport, it seems to me, at least, that  
14 the spatial and temporal scale of the conceptual model  
15 starts to change.

16                  So, one thought I had...and maybe it  
17 makes sense in charge question 8, I guess, we look at  
18 cross-cutting issues, is one place I'm a little  
19 confused now is that we were talking about the aquatic  
20 conceptual model in a pond. We talked about stream  
21 which I was, in my mind, was imagining a stream reach  
22 or maybe an estuary which seems to not be at the same  
23 spatial scale that we were just talking about in a  
24 terrestrial system and maybe not even the same temporal  
25 scale as we were talking in terrestrial systems.



1                   And I may be wrong, and maybe I just  
2 wasn't listening carefully, but I think we may or may  
3 not have a temporal and spatial scale difference in  
4 what we were talking about in the aquatic side and the  
5 terrestrial side. Not that we have to resolve it now,  
6 but maybe when we get to the cross-cutting question, we  
7 could finesse that question a bit and come back and  
8 revisit that.

9                   **DR. HEERINGA:**       I think...at this point,  
10 I think I would like to break for lunch.

11                   And an update on my thinking which won't  
12 necessarily govern the actual progress is I...each of  
13 these questions has a lot of meat to it, and there's a  
14 lot of content that needs to be brought out by the  
15 discussants. It's sort of my...my guess at this point  
16 that I will not try to rush this through this afternoon  
17 and that we will take our time with each of these  
18 remaining questions. They're distinct topics. I would  
19 expect about as much discussion on each, and I would  
20 certainly want to give as much discussion on each.

21                   So, we'll...we'll probably plan to stick  
22 fairly close to the original agenda. That's just for  
23 those of you who are planning your afternoon and your  
24 morning tomorrow morning.

25                   I think that we'll progress at

1 about...we're about one question ahead of the original  
2 agenda, but I...I think that we'll try to stay roughly  
3 on that agenda, and I would expect not to try to force  
4 this to wrap up this afternoon. It's too important to  
5 get all of this information out.

6 So, let's take a...a lunch break, and  
7 we're going to be back here at...let's say we'll start  
8 again at 1:10, so have a little bit more than an hour  
9 for...for our lunch break.

10 **(WHEREUPON** , a luncheon recess was taken.)

11 **DR. HEERINGA:** I'd like to welcome  
12 everybody back to this afternoon session, I guess of  
13 our third day of the meeting of the FIFRA science  
14 advisory panel on the topic of the Selected Issues  
15 Associated with Risk Assessment Processes for  
16 Pesticides with Persistent Biocumulative and Toxic  
17 Characteristics.

18 We are in the process of considering the  
19 charge questions and I think we are up to charge  
20 question 6. Before we do that, I just want to bring  
21 everyone's attention and for the EPA EFED staff, we're  
22 getting copies for you, too.

23 Dr. Cohen was a public presenter  
24 yesterday, has submitted some additional written  
25 clarifications and comments and so just bring that to

1 the attention of the panel and I think, Dr. Simonich,  
2 there's some additional analysis sort of consistent  
3 with the line of discussion that you had, there you may  
4 want to look that over too.

5           Okay, let's begin with charge question  
6 number 6. Dr. Brady, if you would read that into the  
7 record for us, please.

8           **DR. BRADY:**       Okay, charge number 6.  
9 Incorporating multiple exposure routes. There are a  
10 number of organic chemicals with PBT profiles, aquatic  
11 organism exposure for your non-aqueous groups, can be  
12 important relative to direct exposure from water. Most  
13 standard and aquatic toxicity test studies submitted to  
14 the Agency for pesticide registration do not  
15 incorporate realistic chemical exposure through the  
16 diet. Therefore toxicity reference values from these  
17 studies may underestimate actual environmental effects.

18           To address this concern other programs  
19 within the Agency have proposed using a tissue residue  
20 approach for quantifying chemical toxicity. For  
21 quantifying toxicity of organic pesticides with PBT  
22 characteristics, the Agency is also considering the use  
23 of the TRA.

24           Please comment on the strengths and  
25 limitations of the tissue residue approach for

1 addressing pesticides' toxicity from multiple exposure  
2 routes and other methods SAP deems appropriate. In the  
3 context of the tissue residue approach, please comment  
4 on the strengths and limitations of using measured and  
5 predicted tissue residue effect relationships that are  
6 derived from water only exposures in laboratory  
7 toxicity tests.

8 **DR. HEERINGA:** Thank you, Dr. Brady.  
9 Our lead discussant on this question is Dr. Jim Meador.

10 **DR. MEADOR:** I'll go ahead and summarize  
11 the feeling of the sub-group here, Dr. Hickie, Dr.  
12 Oris, Dr. Schlenk and Dr. Bucher and they can chime in  
13 after I go through some things here.

14 Just first a little prelude. If you  
15 look at this section in the White paper you'll notice  
16 that it is not real complete on the tissue residue  
17 approach, and I wanted to point out that on your CD was  
18 this larger document, it's a 60 page document, that  
19 address tissue based criteria for bio-cumulative  
20 compounds. It has a lot more detail on the tissue  
21 residue approach.

22 And I apologize, on these slides you'll  
23 see a lot of acronyms. I'm going to try hard to define  
24 those and spell them out when I get to them but please  
25 bear with me, to save some space and like any

1 sub-discipline we do throw a lot of acronyms around.

2           So TRA we're using the tissue residue  
3 approach for toxicity assessment basically and also on  
4 this particular slide I wanted to point out that it's  
5 not intended to replace ambient toxicity metrics but  
6 supplement and enhance information about toxic  
7 responses. Next slide.

8           So on the first question, the strengths  
9 and limitations of the tissue residue approach, one of  
10 the biggest things we see is a huge reduction of  
11 variability in the toxic response, orders of magnitude.  
12 There are some compounds if you look at like the LC50,  
13 you vary, oh, four or five orders of magnitude over a  
14 number of species.

15           When you look at the tissue residue  
16 toxicity metrics often that boils down to order of  
17 magnitude or less, and in this particular case EC is  
18 the effective concentration, could be sediment or water  
19 that's your ambient toxicity exposure metric and ER we  
20 use R for residue which is tissue residue. P is just  
21 your percent or fraction responding, it could be a  
22 fifty or ten ER 25, whatever.

23           Another very important strength is it  
24 integrates over exposure routes and that's a really,  
25 that's a very large advantage. All exposure models

1 basically incorporate it. Because it accounts for  
2 bioavailability and toxicokinetic rates, you eliminate  
3 the future variability.

4           Most of the variability you see among  
5 species for like an LC50 is due to toxicokinetic rates  
6 and of course when you go to different sites you have  
7 large differences in bioavailability. This helps by  
8 integrating and getting you right to the tissue and  
9 it's sort a gradation from the available compound that  
10 was in the animal, that was in the tissue at the  
11 target site, which we will get into a little bit later.

12           Tissue concentration, especially in the  
13 field they integrate over time and space. That's also a  
14 huge advantage. If you go out and measure water  
15 concentration, if you do that several times on any  
16 given day, it's going to change. Sediment concentration  
17 is very heterogenous. When you're assessing toxicity,  
18 having a tissue residue that integrates over time and  
19 space gives you a much better feel for what the  
20 animal's been exposed to, much better metric.

21           It's also very advantageous for  
22 assessing toxicity in the field. You can go out based  
23 on lab studies maybe you had a good feel for what the  
24 tissue concentration was telling you as far as toxic  
25 response. You can measure that concentration and have

1 a pretty good idea how the organisms are doing. It  
2 doesn't work very well for lethal responses, but most  
3 of it for sub-lethal responses you might have an idea.  
4 It's very good for mixtures but you need a lot more  
5 information on mode of mechanism of action and I'll  
6 explain this.

7                   Currently mode of action and mechanism  
8 of action are defined differently. Often they're used  
9 interchangeably but they're not. Mode of action is a  
10 general concept like uncoupling oxidative  
11 phosphorylation, acetylcholinesterase inhibition,  
12 there's a number of modes of action. Those modes of  
13 action, you can have a toxic response by many different  
14 mechanisms of action. For example, uncoupling  
15 oxidative phosphorylation, that can happen with every  
16 different mechanism.

17                   Tribunal... are both uncouplers as a  
18 mode but they act by very different chemical  
19 mechanisms. You think of a mechanism as an actual  
20 biochemical event and that becomes very important when  
21 you're looking at mixtures and assessing let's say  
22 response versus dose standard. A response additive you  
23 can do, let's say you have a growth response, which  
24 operates maybe by different modes of action. A growth  
25 response you can add those together in a mixture.

1           If you're talking about dose additive  
2 compounds, that has to be a mechanism specific.  
3 Basically the compounds act as dilutions of each other  
4 and you can add them with some of the response and  
5 that's a whole another area which we're not going to  
6 get into, but I just wanted to point out the difference  
7 between mechanism and mode and how you can you use this  
8 in the long run for mixtures which is a huge step.

9           In the current way we do things, it's  
10 looking at single compounds, all these toxicity  
11 evaluations are based on compound by compound. In the  
12 environment we know that doesn't occur. There's lots of  
13 compounds out there that really need to be considered.

14           Additional strengths, it's highly  
15 defensible, the TRA, for translating back to water or  
16 sediment concentrations or water quality criteria or  
17 sediment quality criteria. These can be guidelines to  
18 criteria, whatever you want to call them, thresholds.  
19 A simple example here is the water concentrations.

20           If you define a tissue toxicity  
21 reference value, and I think it's a little different  
22 than the way it was in the White paper. This again, I  
23 have to define the definition. A CBR is a critical  
24 body residue. That's a general term for, it's a  
25 statistical concept of many different responses,



1 toxicity metrics. LR 50 is a CBR, ER 50 is a type of  
2 CBR. That is a critical body residue and you can  
3 define it many different ways.

4           In the second line here you can see I  
5 talked about looking at these values, if you have a  
6 given compound for a number of species, let's say you  
7 have an ER10 for a bunch of species, you can do a  
8 species sensitivity distribution, that's the SSD, take  
9 the fifth percentile and you could call that your  
10 tissue toxicity reference value.

11           So back up above that you see for a  
12 tissue TRD, if you divide that by the BCF you can get a  
13 water quality guideline. It's basically just a  
14 mathematical rearrangement of the equations to solve  
15 for tissue or water or whatever you have.

16           It's great for sediment, nowadays it's  
17 sediment quality guidelines are basically looked at and  
18 some recordative responses with a bunch of sediment  
19 bioassays that really don't address individual  
20 compounds. This is one way to get at that by  
21 determining the tissue residue effect and looking  
22 backwards through a BAF or a BSAF to get to a sediment  
23 concentration.

24           And within these species sensitivity  
25 distributions, most people look at the ninety-fifth

1 percentile, basically the fifth percent of the SSD and  
2 for that ninety five percent lower confidence interval  
3 is the value that would be used.

4           So for the BCF I mean there's different  
5 ways to approach it, this is just one example. You can  
6 take the ninety fifth percentile using a cumulative  
7 distribution function with all the BCFs and calculate  
8 back. You can use a main value or you could use a model  
9 value, this is one approach.

10           This is one way you could translate back  
11 for water or sediment. It seems backwards but it's,  
12 you know, all fluid, you can go back and forth. But  
13 going with the tissue residue with the low variance is  
14 actually a very strong way to look at these things.

15           In general tissue residue toxicity is  
16 relatively time independent and I'll get back to this  
17 in another slide, but there are studies showing that  
18 there is some compounds that exhibit time dependency  
19 but that kind of goes away after roughly about four  
20 days. So that's also a very important thing. You can  
21 actually do shorter term experiments and you get a very  
22 similar tissue concentration where an effect occurs, if  
23 it's fifty percent lower or twenty five percent lower  
24 or whatever and that doesn't change over time.

25           Another interesting point in a strength

1 for the tissue residue approach is that you actually  
2 may get away with using fewer species to assess  
3 toxicity or the TRB.

4           Because of this much lower variance  
5 which we have for these different responses, you really  
6 would, could possibly get by with fewer data points,  
7 and this works with the new response and I put this up  
8 there because a lot of people don't realize if you look  
9 at a bunch of say LR 50s for a given species, those  
10 values can be normally distributed. It's not always  
11 log normally distributed. And that's actually if you  
12 think about it what you might expect.

13           So you could use a mean or standard  
14 deviation or standard air removal if you want. If you  
15 go to an SSD approach and then you can do the HC05 the  
16 hazard concentration, the fifth percentile and say use  
17 this ninety five percent lower confidence interval.  
18 That's also variance driven, so that also would be a  
19 much tighter estimate as compared to an SSD for, just  
20 for a bunch of LC50s.

21           So it's something to consider, I mean  
22 there in Europe, in some cases for SSD that it would be  
23 one of four species or four different taxa. Here like  
24 the water cholera criteria it's basically eight  
25 different taxas, so when you think about it, it's a

1 minor point but in the long run you'll start to see if  
2 you start looking at a bunch of CBRs they kind of  
3 converge around one value or a much narrower range of  
4 values. Next slide, please.

5           Okay, some of the limitations, there are  
6 a few to the tissue residue approach. It doesn't work  
7 for highly metabolized compounds, but that doesn't  
8 preclude other compounds that are metabolized, for  
9 example polycyclic aromatic hydrocarbons, it doesn't  
10 work very well.

11           Although we're finding recently that in  
12 bile you get like a bile metabolite and you get a very  
13 hard core relation between the dose that you give the  
14 animals that are left there, so there is a possibility  
15 of using that. It's not a tissue, it's a fluid but  
16 it's still an internal representation of the dose,  
17 surrogate like all these are.

18           Tributyl-10, actually in some species  
19 that's ninety percent metabolite. Tributyl-10 is one  
20 of our best examples for the tissue residue approach,  
21 it actually exhibits a CBR with a very consistent value  
22 of the co-efficient variation of about forty percent of  
23 the eleven species that we actually have LR 50s for.  
24 You do get increased information required for this,  
25 again the toxic action, the mode and mechanism.

1           It's really nice to know something about  
2 that especially if we take it a step further and look  
3 at metabolites or mixtures. Rates, which will come up  
4 in a bit for PBBK, it's just more information you need,  
5 it's not simple as just doing a standard LC50 assay or  
6 just a regular bioaccumulation assay, you do often need  
7 more information.

8           Another drawback which may not apply  
9 here because you're looking at new compounds and you're  
10 having, you know, this one's conduct experiments in  
11 general there's very few studies that have actually  
12 generated CBRs or tissue residue based toxicity  
13 metrics. Many of those are LOERs, lowest observed  
14 effect residues. We really like to see a dose response  
15 that's the ER or LC, something that's typical  
16 regression, you had a lot more information from that.

17           Very few endpoints have actually been  
18 looked at. The standard ones, mortality, growth and  
19 reproduction, the big three, there's other endpoints we  
20 think are important and there are three basic data  
21 bases. The Army Corps of Engineers runs one called  
22 ERED, there's George Bennett Inkley data base that  
23 actually I think is being merged now a bit with the  
24 ERED Army Corps data base and the PCB Lens data base  
25 which has moved from EPA which has got a lot of great

1 information in it.

2           The people are starting to put these  
3 things together, but we're still limited with the  
4 amount of data that are out there so it's hard to make  
5 some generalizations for a lot of compounds. Some  
6 compounds you just have absolutely no data. Of course  
7 there's confounding factors, lipids, organism held  
8 temperature, but these are really the same things you  
9 find for your ambient exposure metrics. I mean it's the  
10 same sort of thing but they do have to be considered  
11 and adjusted for.

12           And of course you need to consider the  
13 toxicity metabolites. Metabolites can actually  
14 confound things quite a bit and an assay on the next  
15 slide will have some information on that.

16           Well, that was basically it for number  
17 one and at the end here I have some discussion points  
18 and a recommendation which will apply to both of these  
19 and kind of come back to some of the points I made here  
20 so I think maybe I'll just go through question number  
21 two now and look at that and then we'll go back and we  
22 can talk about all these together.

23           So question two is the strengths and  
24 limitations on the predicted tissue residue effect  
25 relationships that are derived from water only

1 exposures live studies. So strengths and limitations  
2 for those water exposures. Some strengths, basically  
3 water only exposures are acceptable, it doesn't matter  
4 you have a tissue concentration, you can get that  
5 through a dietary exposure or water exposure.

6           Some things to keep in mind though is  
7 you do need sufficient time for internal redistribution  
8 of the contaminant. It's basically a different route  
9 whether it's taken up by the gill or the gut and enter  
10 the circulatory system differently so some of these  
11 very hydrophobic things just need some time to  
12 redistribute and get to the target site and that's just  
13 going to be a best professional judgment I think on how  
14 long that will take. It really depends on the compound.

15           And of course another strength is the  
16 route of uptake is really less important looking at  
17 tissue residue approach so to answer the question  
18 basically BCF tests I think would be just fine for  
19 generating tissue residue values to be used. Next  
20 slide, please.

21           Some limitations. One important point is  
22 the toxicity of bioaccumulation based values may not,  
23 for some compounds may not be amenable to QUASAR. I've  
24 seen at least one example where it really doesn't  
25 match.

1 Tributyl-10 is one although it's a  
2 ionizable polar hydrosorbic organic metallic, it's an  
3 odd compound but you're talking about new compounds in  
4 an lot of your assessments that you're doing that have  
5 characteristics you're not too sure about so in some  
6 cases some of those may not be amenable to QUASAR,  
7 standard QUASAR modeling, so it's just something to  
8 keep in mind. So in that case measured values would  
9 actually be preferred.

10 The next one is actually probably more  
11 of a recommendation but there is a bit of a limitation  
12 because often not many doses are used so several doses  
13 really should be tested because we've found in some  
14 compounds and you can see this for pHs, PCBs,  
15 Tributyl-10, others, you have multiple modes and  
16 mechanisms of action that are dependent on dose and  
17 actually time, which really is a huge confounding  
18 factor that has to be considered so just because you're  
19 testing a relatively high concentration and get an  
20 effect doesn't mean there's some, not something going  
21 on at a lower concentration.

22 TBT is a great example. Just recently we  
23 found that fish were responding at concentrations as  
24 low as the snails are to get eco effects, which are  
25 extremely low. Before it was just growth and mortality



1 and some other reproductive effects but down at a  
2 couple of nanograms per liter, parts per trillion in  
3 water fish respond, but nobody really ever tested those  
4 concentrations before.

5           So obviously you need a huge range in  
6 dosing and that's also the best professional judgment  
7 what those doses are, but you need to capture those  
8 different responses with different modes and mechanisms  
9 and of course sufficient time for exposure is needed.  
10 The time, the compounds that, like Peter Landon has  
11 found, that are time dependent have a very strong time  
12 dependency for the first four days.

13           After that, it's really almost  
14 negligible and of course there's other compounds that  
15 may exhibit longer time traces when you plot them out,  
16 but for most of the chemicals we've looked at where we  
17 have CBRs, over time, they really don't change much  
18 after four days, it was a hundred hours in Peter's  
19 case, the compound he looked at so again, that's sort  
20 of, of course, doing long term experiments. Next  
21 slide, please.

22           So these points to consider kind of  
23 relate to both of the questions and the kind of  
24 overarching thing. Metabolites is something that was  
25 mentioned. They may be more or less or equally toxic.

1 In general they're often less toxic when you metabolize  
2 these things or hydrophobicity changes conjugated the  
3 sequestration on some that really makes it less toxic  
4 especially for specific mechanism of action.

5           If it's nonspecific those compounds still  
6 may be able to contribute to the membrane disruption.  
7 I'm not using narcosis any, well, narcosis is kind of  
8 an odd term because it's based on a behavior. It's  
9 really nonspecific which as a mode of action it's not  
10 specific. It's baseline or nonspecific, it's basically  
11 a membrane disruption and that's the mortality response  
12 you can get with chemicals that occurs at around two to  
13 eight micromoles per gram or fifty micromoles per gram  
14 of lipid.

15           So in general we find, you know, you  
16 have a parent compound in an animal, it's probably  
17 going to change. It could actually be more toxic, I  
18 mean we have reactive compounds. We basically have  
19 nonspecific, specific active compounds or reactive.  
20 Reactive is something like binding the DNA or a mollusk  
21 ion is activated to an oxon forage, universally binds  
22 with acetlycholinesterase and reactive compound, and  
23 also reactive compound you can't really do much with  
24 for the tissue residue approach although some people  
25 are starting to model it. We think there is a way to

1 model that.

2                   So definitely keep in mind the toxicity  
3 of the parent compound through looking at these things  
4 in tissue. It's probably not safe to assume that  
5 they're equally toxic unless you're pretty sure you may  
6 have a nonspecific narcosis type mode of action and it  
7 may contribute to the overall response. In many cases  
8 we really don't know what the mechanism of action is  
9 for these compounds.

10                   A few we do, most of them we don't. We  
11 know general modes which is great. You can start if you  
12 look at McCarty and Mackay's 1993 paper they have a  
13 whole bunch of mode of actions and we see about a six  
14 order of magnitude range in response from baseline  
15 toxicity all the way to dioxin toxicity and lots of  
16 things in between there, and couplers, you get them,  
17 irritants, the polar compounds, the  
18 pseudocholesterase inhibitors which are the general  
19 modes, and as I think I mentioned earlier, multiple  
20 modes and mechanisms for given compounds make things  
21 very confusing.

22                   pHs, PCB, they also, all have multiple  
23 modes of mechanisms that are often dose and time  
24 dependent, so I'm not sure how you deal with that,  
25 that's kind of a tough one. If it comes up you have



1 to, you know, learn to recognize that there's a  
2 possibility, especially time dependent. I mean, an  
3 animal might die from an excess dose as a baseline  
4 toxicant and then later on you know, it might die from  
5 an immuno compromised response. All we have is a dead  
6 animal so we really don't know what killed it, so it's  
7 definitely something to consider when you're looking at  
8 long term experiments. Thank you.

9           Some recommendations that I'm looking at  
10 tissues, most of the data we have now is for whole body  
11 animals. Most of it's obviously aquatic. People look at  
12 invertebrates and fish but there's other species to  
13 consider obviously. For small species, whole body's  
14 fine. You get into fish, you might want to consider  
15 different organs. Definitely in larger animals you have  
16 to consider organs or even plasma.

17           Egg works for birds in a lot of cases  
18 and then you know, this is something, kind of a future  
19 thing which we probably wouldn't get into now since  
20 the, a simple thing is doing whole body.

21           In the future you might want to consider  
22 the tissues and with that the PBBK modeling, we have  
23 rates and all that 'cause these compounds actually have  
24 a target and it's often organ specific not always but  
25 often it is and that's just another step closer to

1 reducing the variability and characterizing response,  
2 but using whole body is actually fine for now because  
3 most of the compounds we looked at, there's a pretty  
4 good proportionality between what's in the whole body  
5 and what's at the target, but that's not always going  
6 to be the case, so it's something to keep in mind.

7           Again, consider long term exposure is  
8 more than ten days, and sublethal effects really are  
9 what are protecting chronic effects in the field.  
10 Consider additional responses, that means behavior,  
11 olfaction, inhibition of olfaction, immuno-compromise,  
12 all these could lead to mortality, population level  
13 effects.

14           And also I'd like to make a pitch for  
15 hormesis, which could be considered an adverse effect.  
16 We've seen cases where a compound, there's a new class  
17 of compounds called abusagens. Thiolate, Tributyl-10,  
18 they're all being used to make animals bigger. I've  
19 seen it in fish.

20           The controls for the, the lotus fish are  
21 thirty percent larger than the controls. And it may  
22 seem like a good thing, but it's really not because  
23 these fish are really finely tuned on their cycles. For  
24 salmon in particular, the larger juveniles come back  
25 early, they come back in two years instead of four

1 years so the fitness is really affected for the  
2 population so it's not always a good thing, it actually  
3 could be an adverse effect. So it's, I'm just throwing  
4 that out, another response to consider.

5           Next slide please. Define and clearly  
6 state your assumptions, limitations for the tissue  
7 residue approach and that's something I think Jim Oris  
8 will probably bring up again. He did earlier  
9 yesterday. Use specific data for the acute to chronic  
10 ratio, and here I want to make a distinction, acute and  
11 chronic.

12           Acute is a time thing, it's exposure's  
13 acute or chronic, long term or short term and the  
14 response is basically lethal or sub-lethal, it's not  
15 really a chronic response or an acute response, so I  
16 know you have short term and long term mortality,  
17 sublethal so in some cases there's an ACR that's  
18 developed or more appropriately for some responses a  
19 lethal to sub-lethal ratio.

20           I know a lot of people have done reviews  
21 in literature and they've come up with a value of about  
22 ten as an average but if you look at the range in this  
23 data, were huge, a lot of pesticides we find a  
24 thousand-fold difference between lethal and sub-lethal  
25 responses and just because you have an acute or a

1 lethal response, dividing by ten doesn't really get you  
2 to a protective concentration.

3 Determine taxa's, specific TRVs,  
4 obviously it doesn't work when you lump invertebrates  
5 and fish together in some cases. Documents like  
6 toxicity is one sleeve's another example, EPA document  
7 from 2004, was basically fish reproductive effects so  
8 really it's important to pay attention to the taxier  
9 putting in here future sensitivity distributions, and  
10 it really should be endpoint specific if you have the  
11 data. If you have growth for a bunch of species, and  
12 specifically like an ER 25 or ER 50, you start mixing  
13 endpoints and you get a lot more variability and that  
14 sort of defeats the purpose.

15 And in general we recommend the tissue  
16 residue approach for toxicity assessment for all  
17 bioaccumulative compounds. It's not just the very  
18 hydrophobic compounds, it works for compounds of KOWs  
19 two or three, anything that's bioaccumulative is  
20 amenable to this approach and of course I don't have to  
21 say this but you know, develop toxicity testing  
22 framework to acquire high quality data which goes back  
23 to the first point here, defining and clearly stating  
24 assumption and limitations through the approach in how  
25 you're collecting your data, and I think that's all I

1 have. Yeah.

2 **DR. HEERINGA:** Thank you, Dr. Meader.  
3 Organized presentation. Dr. Hickie is the first of the  
4 associate discussants.

5 **DR. HICKIE:** Thank you, Dr. Meader, for  
6 a very thorough overview and I only have a couple of  
7 things to add to that and it, I guess the main thing is  
8 thinking in terms of using this approach for chronic  
9 toxicity and one thing I'd like to bring up is that if  
10 you look at tissue residue in an individual animal over  
11 its lifetime, and the concentrations can vary  
12 considerably even if they have a vaccine exposure  
13 concentration throughout the lifetime and there's a  
14 number of factors that come into play, biological  
15 factors largely.

16 For a mammal it could be offloading the  
17 contaminant in utero, thinking about the milk. That  
18 can be followed by a growth dilution effect. Changes in  
19 fat stores over the lifetime results in increase or  
20 decrease in concentrations in throat and body.  
21 Reproductive losses by females can be considerable and  
22 if at some point in life there is, you reach a  
23 threshold where you get induction of metabolite or  
24 biotransformation, it can start bringing things down  
25 and with some of the work I've been doing, I just went



1 through and looked at some data.

2           But this can, in an individual, modeled  
3 individual at least, we end up with almost an order of  
4 magnitude range of concentration over the lifetime of  
5 I'm using marine mammal as an example here but I  
6 wouldn't be surprised if it would be similar in other  
7 species, and this makes it quite challenging because  
8 you now have a temporal tissue concentration if you're,  
9 and you're trying to connect that somehow with the  
10 chronic effect and that causes a few problems. If you  
11 then have to rely on modeling these tissue  
12 concentrations, your uncertainty expands that range  
13 even further sort of making it a little bit trickier to  
14 draw connections.

15           And looking at the Armitage-Gobas shrew  
16 earthworm paper, if you look at their figures where  
17 they've looked at observed versus predicted  
18 concentrations, the predicted concentrations ninety  
19 five percent confidence limits are several orders of  
20 magnitude and substantially larger than measured ones,  
21 so I think this is a distinct problem to be aware of if  
22 we're going to use tissue concentrations in, to address  
23 chronic toxicity.

24           One of those aspects is the aspect of a  
25 temporal disconnect between the tissue concentration

1 you have and if you, your chronic effect only shows up  
2 later, you really don't know how those two connect.

3 I think just one other comment I'd like  
4 to make, and following up on your points about PAHs and  
5 that they're metabolized and they don't really  
6 bioconcentrate, I played around with this a little  
7 while ago and it's one of the things to publish, but  
8 you can model that sort of thing and rather than  
9 focusing on tissue concentrations you can focus on the  
10 movement of the PAH into the organism and it being  
11 processed, and perhaps there's some sort of dose metric  
12 to draw to that in terms of exposure.

13 Beyond that I worked on this area for  
14 acute toxicity to neutral narcotics to fish as part of  
15 my Ph.D. work and I think it works very well for,  
16 certainly for acute things and I think we're on a  
17 learning curve for how it works for chronic.

18 **DR. HEERINGA:** Thank you, Dr. Hickie.  
19 Dr. Oris.

20 **DR. ORIS:** Thanks. I don't have a whole  
21 lot more to add. The only thing that I would say is  
22 sort of pile on on the concerns about working on  
23 chronic issues, especially related to being able to  
24 apply these to population level effects and that's I  
25 think going to be the real challenge.



1                   **DR. HEERINGA:**       Dr. Schlenk?

2                   **DR. SCHLENK:**       I also, great job, Jim, on  
3 presenting that. I think you presented pretty much  
4 everything we had discussed. A couple of things I just  
5 wanted to highlight and I've been saying this I think  
6 in some of the question and answer periods and again  
7 with Keith's prior life in terms of selenium I think  
8 you probably, it's like preaching to the choir.

9                   I think in terms of this approach so I  
10 think that I totally agree in the strengths in terms of  
11 for these, for all bioaccumulative compounds for that  
12 regard. I think it's definitely the logical way to go.  
13 I think it incorporates all the exposures that we're  
14 interested in and especially the oral exposures which  
15 again for the tradivores I think it's huge and  
16 particularly in a modeling system I think that needs to  
17 be addressed, the oral exposure to tradivores,  
18 particularly with the size class issues with VOC and  
19 the compound in the aqueous medium anyway.

20                  And since Jim hit all the strengths so  
21 hard I'm going to just kind of hit a few of the  
22 weaknesses a bit and again, we kind of talked about  
23 this earlier but I think it's really important to try  
24 to compartmentalize things as much as you can, I know  
25 it's difficult particularly for the inverts to do that.



1 Again John Nichols' work with the fish I think is  
2 instrumental in this regard in terms of the  
3 compartmentalization, particularly with the lipid  
4 storage component.

5           This was brought up I think by Jim with  
6 the terrestrial thing, but it is hugely important in  
7 fish as a compartmental component to that. In fact if  
8 you had to just pick one compartment and split it into  
9 two, that would be one in a tiered approach if you want  
10 it all so that's the one I would sort of hammer on  
11 would be a lipid component in that.

12           Biotransformation of course,  
13 particularly with these compounds already kind of  
14 discussed that a bit as another component to that  
15 compartmentalization perhaps. And again let me just  
16 reiterate Jim's comment on determining the target organ  
17 I think is critical, I mean selenium is a great example  
18 in that regard. I mean we're pretty fortunate that,  
19 you know, you've got that you can target the gonad, the  
20 eggs and actually get a nice, you know, critical  
21 residue that corresponds to a developmental effect.

22           And I think the real fear I have and  
23 again this kind of goes back to my comments yesterday,  
24 it's just, you know, assuming that you have acute  
25 toxicity and I'm, again I know this is probably going

1 to fall on deaf ears to a certain degree but I think  
2 the whole narcosis aspect is a little bit, I think we  
3 need to move on beyond that in terms of assuming  
4 narcosis is a mode of action for everything.

5           It worked, you know, ten, fifteen years  
6 ago, but now I think we're seeing that, I mean ethanol  
7 is a great example mechanistically. We used to think  
8 that its mode of action was, you know, membrane  
9 disruption, it's not, there's specific receptors that  
10 ethanol interacts with.

11           pH is a great example, Johnny Cordona's  
12 work at NOAH has indicated that you have different  
13 mechanisms of action with three, four, five ring  
14 compounds that don't correspond to a narcosis based  
15 reaction and I think that has dramatic effects on your  
16 assumptions of additivity as well as assumptions in  
17 terms of accumulation and how they interact at  
18 different levels of the ecosystem so I guess those  
19 would be things that I would caution against, you know,  
20 similarities in structure do not equate to similarities  
21 in toxicity and again, I'm sure you guys are probably  
22 aware of that so just take that into account.

23           Let's see, anything else here. Oh, just  
24 one other thing. Again we, I'm sure you're aware of  
25 the model that's being proposed in terms of focusing on

1 mode of action deriving hypoth...

2 Don was in the meeting the other day  
3 actually as far which was presented by Vicky Delarco, I  
4 guess, where again, you sort of set a model if you will  
5 or a mode of action hypothesis and then that drives  
6 your testing,

7 And I think if you do that instead of,  
8 you know, rely on twenty different studies that you'll  
9 actually can refine the testing into specific questions  
10 that allow you to really get the good models that will  
11 allow you to not only evaluate single compounds of PBTs  
12 but even mixtures because if you think about it, again  
13 in the human health realm, pharmacists base, you know,  
14 common geriatric patient takes nine medications and  
15 that's a mixture situation and the way that the risk is  
16 evaluated on that is by mode of action.

17 And I think we really need to pursue  
18 that in terms of the Agency's approach in a mixture  
19 setting.

20 So again, reiterate mode of action  
21 approach, mechanism of action approach and I think that  
22 is already being done but I just want to, you know,  
23 emphasize that so it's not just lost in the human  
24 health folks but specifically in the eco side I think  
25 we really need to pursue that and I think this is a

1 good first step in moving that direction but I wouldn't  
2 stop there, likewise I think narcosis was a good first  
3 step but I don't think we need to stop there, we  
4 definitely need to specify and reduce uncertainty in  
5 that regard so...

6 **DR. HEERINGA:** Thank you very much for  
7 the assigned discussants, turn to the panel or to any  
8 of you. Yes, Dr. Meador?

9 **DR. MEADOR:** There is one more  
10 discussant.

11 **DR. HEERINGA:** I'm sorry, Bucher?

12 **DR. MEADOR:** John Bucher.

13 **DR. HEERINGA:** John Bucher actually had  
14 to leave he, I think this being all day it took him  
15 away, so figuratively. Dr. Norstrom.

16 **DR. NORSTROM:** If I can make some sense  
17 out of my hen scratches here. I'll start with  
18 commenting on Dr. Schlenk's comment. I wonder whether  
19 we should be focusing again for some of these near  
20 chemicals on lipid compartments.

21 This pesticide four, for example, I  
22 think it might be quite intriguing given the fact that  
23 there seem to be some inconsistencies to see exactly  
24 how it is distributed.

25 Also the whole question of metabolites.

1 There are some peculiarities out there, for example,  
2 again going back to organo-halogens,  
3 alga-corto-benzo-dioxin for some peculiar reason in  
4 fish seems to be excreted in bile as an unchanged  
5 compound.

6           Mass balance studies shown, for example,  
7 in the Baltic that they couldn't account for it unless  
8 they list it as kind of lost so those kinds of things  
9 don't always work and we should be again thinking  
10 outside the box I think for a lot of these types of  
11 compounds unless they truly aren't metabolized.

12           The question of concentration  
13 dependence, I have in front of me here a paper by, who  
14 is it, Simon and Hermans on concentration dependence of  
15 lethal body burdens over time and they make some fairly  
16 interesting comparisons here that, for example, over a  
17 one day exposure and four day exposure that there's  
18 sort of variation of the lethal body burdens.

19           Some fish died in one and some died in  
20 the other, and I'm wondering whether this is something  
21 that the one even for acute exposure shouldn't be a  
22 little bit cautious about. I'd have to go into some  
23 more detail, and I don't really want to go in and  
24 describe what they're actually doing here but it is not  
25 entirely true in all cases apparently according to this

1 paper that one could just sort of assume that lethal  
2 body burdens are not time dependent even in acute  
3 exposures. So it may be something to consider.

4           Biomarkers, I wonder whether a biomarker  
5 is something that anybody considered in the panel.  
6 Cholinesterase, for example, as opposed to an actual  
7 body burden because in some cases these things you're  
8 not going to see but you might have a biomarker that's  
9 there which is dependent on the exposure and you can  
10 correlate exposure to the biomarker response, and it's  
11 quite specific.

12           There are a lot that I think are  
13 useless. For example, I know that I don't believe  
14 personally that things like EROD activity is all that  
15 useful as a metric for anything more than sort of an  
16 order of magnitude type differences in exposure but  
17 nevertheless there are some that are fairly well  
18 developed.

19           What else did I have here? Oh, my  
20 comment on the usefulness of bird eggs. I don't think  
21 actually they're very useful at all unless it is a  
22 microfilic compound. Most polar compounds don't make  
23 it into an egg, they're formed over very quick length  
24 of time and the constituents are packaged in the liver  
25 and even for organo-halogens probably about fifty

1 percent of the lipid that ends up in a bird egg is  
2 actually coming directly from the diet, it is not an  
3 equilibrium addressed in the body so it's not  
4 necessarily a very good tissue to be using for birds.

5 And I think that was it, thanks.

6 **DR. HEERINGA:** Thank you, Dr. Norstrom.  
7 Just mention, too, that I did speak to Dr. Bucher and  
8 he said that in your working group discussions that he  
9 felt he supported and didn't have anything to add  
10 really to what was being discussed at large in the  
11 group. Dr. Meador?

12 **DR. MEADOR:** Jim Meador, I'll just  
13 respond to Dr. Norstrom's point about biomarkers. We  
14 are considering biliary effect of the polycyclic  
15 aromatic hydrocarbons and did a dose response feeding  
16 study with fish and got a correlation of .86 between  
17 the dose, micrograms per gram fish per day and the  
18 ancillary fat in bile. So in my mind we're actually  
19 starting to use this data.

20 To my mind you can use that as a  
21 surrogate for term dose, go out in the field and  
22 measure the fat of the animals and know what kind of  
23 exposure they had, so the biomarkers do work in some  
24 cases and that's just one example, there may be others,  
25 just have to look.



1                   **DR. HEERINGA:**       Additional comments from  
2 the panel on question number six? Peter.

3                   **DR. DELORME:**       Just a couple of practical  
4 comments as per usual for me, I'm probably going to  
5 sound like a broken record but in the short term I  
6 think you're going to be hampered by the lack of  
7 available data, okay, and you're not going to have  
8 actual measured concentrations until you actually make  
9 changes to the study protocol or have different kinds  
10 of studies made.

11                               So I mean that's going to leave you  
12 relying on conversion of existing data, there is  
13 uncertainty there. You need to understand that  
14 uncertainty, you need to understand the variability  
15 especially with respect to species sensitivity. I was  
16 actually glad to see the FSB stuff, I mean that's not  
17 new to EFED, it's not new to PMRE.

18                               There should be some consideration of  
19 that in trying to get some sort of assessment of the  
20 performance of the conversions to understand the  
21 variability and the uncertainty around it. I think you  
22 can get that through mining of existing data to a  
23 certain extent again.

24                               But I think until protocols are changed  
25 to actually require tissue residues be measured for,

1 you know, PBT type substances, you know, there's going  
2 to be a little bit of a gap there and along with that I  
3 mean the other practical thing is the registrants are  
4 going to want some sort of criteria to guide them as to  
5 when they might want to do that.

6 **DR. HEERINGA:** Turn to Brian and  
7 Christina, Keith, any follow up questions?

8 **MR. SAPPINGTON:** Yes, Keith Sappington.  
9 I have on the note of protocol development, I think  
10 that's one area that will be very useful to us to look  
11 to your recommendations on changes. These are, the  
12 cycle which these are revised varies but it does take  
13 quite a long time and even when you think they're just  
14 about out the door, they're never really out the door.

15 With the issue of measurement of tissue  
16 residues and this gets back to even the concept of  
17 using a PBBK type model is ultimately you have to  
18 relate it, if you're going to predict the concentration  
19 in a specific tissue then you need to actually have  
20 that aligned with your effects data as well, or at  
21 least be able to extrapolate that in some way.

22 Right now the protocol for avian  
23 reproduction tests has a loose recommendation in it  
24 above log KOW of three, it's recommended that at least  
25 one tissue be selected and have compounds measured in

1 that, so we don't obviously always get those types of  
2 measurements but again thinking about if, I don't know  
3 if this would always have to occur within the context  
4 of the guidelines themselves, ultimately we want them  
5 there.

6 But even outside of that if we could  
7 give recommendations as to measurement of those tissues  
8 and it was brought up earlier that, wow, it would be  
9 nice to have measurements over time and not just at the  
10 end of the study as well so I just put a plug into  
11 that, that yeah, we are living with the guidelines we  
12 have right now but we can always look back to your  
13 report if you consider that and prospectively we might  
14 be able to make some useful changes or incorporate that  
15 as we ask for additional data in that specific  
16 assessment.

17 I have one other clarifying question.  
18 And it gets to the notion of well, I'm not convinced  
19 it's just time dependent, I think it's many aspects, it  
20 could be mode of action, mechanism of action,  
21 dependence, but the notion of acute versus chronic in  
22 the context of tissue residue values, even back in  
23 McCarty and Mackay's paper they split out the CBRs for  
24 sort of acute versus chronic.

25 And I just, my sense is that we would

1 follow a similar path partly in that in the absence of  
2 information we may not be having the same mode of  
3 action or mechanism of action from a very sort of high  
4 dose or high concentration short term exposure versus  
5 what's going on in the long term even with different  
6 life stages so I'm just sort of we begin to get some  
7 feedback on the notion of at least stratifying tissue  
8 residue type measurements unless you have data  
9 otherwise by sort of acute versus chronic.

10 **DR. ANDERSON:** One more said on a little  
11 bit what Keith was saying, the term earlier the acute  
12 chronic ratio that was discussed for general narcosis  
13 the, I guess I would just ask to just for consideration  
14 of, if other methods you believe are useful in  
15 estimating chronic toxicity from the acute values.

16 The presentation that was given for  
17 chemical four by then public comment there was  
18 methodology to extrapolate to a chronic value from an  
19 acute value like in LCO1 or something like that but I  
20 guess I would just also seek some comment on utility of  
21 other methods to extrapolate the chronic effects.

22 **DR. HEERINGA:** Panel members, any  
23 response on those particular questions, the  
24 extrapolation conversion from acute values to chronic  
25 values. Dr. Meador, do you have....



1                   **DR. MEADOR:**       Well, I sure can't think of  
2 any methods, I mean actually measuring it, having real  
3 data is the only way to go. It does seem to work for  
4 baseline toxicity. The factor of ten is actually not  
5 too bad for some of the, especially if you've been  
6 going from lethal to say like a growth response.

7                   Often it's the same mode of action, the  
8 baseline. When you get into specific mechanisms of  
9 action, it's all over the map and I don't think there's  
10 any way to predict that with any QUASAR modeling or  
11 anything like that.

12                  **DR. HEERINGA:**       Dr. Schlenk?

13                  **DR. SCHLENK:**       Yeah, I just would say  
14 getting back into your first comments as far as if you  
15 had a tissue to pull, you know, and I think it even  
16 relates to the chronic endpoints, you know, obviously  
17 if you've got gonadal material, highly lipoidous  
18 material, I think if I had a place to start that's  
19 where I would go in terms of that and relate that to,  
20 you know, development, reproductive development.

21                  It kind of gets to what Jim was talking  
22 about, I think that's going to be your best approach in  
23 terms of a population level effect in that regard.

24                  If I had to do number two, I'd obviously  
25 do liver as another site, and I don't know those are

1 kind of, you've got a non-spawning animal it's hard to  
2 get a gonad but or a hepatopancreas for example in an  
3 invert would be another sort of tissue based approach  
4 if highly lipoidous tissue for that, and those by and  
5 large tend to.

6 I mean I don't know exact numbers but if  
7 I had to take a guess, my best expert, whatever that  
8 means, opinion it would be your, as far as reproduction  
9 is concerned those would be the tissues you'd try to  
10 tie it to in terms of body burden concentration and  
11 time dependent concentrations in those particular  
12 tissues. I mean at least for now anyway.

13 **DR. HEERINGA:** Dr. Hickie?

14 **DR. HICKIE:** I'd agree with Dr.  
15 Schlenk's comment that either lipid stores or liver  
16 would be the preferred choices and maybe you can  
17 refresh me, did you mention in measuring residues from  
18 a particular treatment, did you specify a specific one  
19 they should measure it from?

20 **MR. SAPPINGTON:** The tissue is not  
21 specified and I don't recall if it's even specific  
22 enough to say which treatments or it's being measured.  
23 I have to go back and check and obviously we'd like to  
24 have a residue response relationship because if you  
25 happen to measure a contaminant in a tissue that's not

1 correlated to, you know, well and you're just doing  
2 that at one treatment level, it's nice to have the  
3 proof of residue response in a study like that.

4 **DR. HICKIE:** I would want to see another  
5 replicate to do that type of work, and it might, it  
6 would be useful to know ahead of time to require that  
7 rather than to be always in the position of having to  
8 estimate the residue. You can always have them collect  
9 the tissues to do that so it's there waiting to go and  
10 then I would suggest that most observed effect  
11 concentration or dose that they derive from the test  
12 and if you could do two it would be the lowest and the  
13 no observed treatments.

14 **DR. HEERINGA:** Dr. Norstrom?

15 **DR. NORSTROM:** Just a question, what's  
16 wrong with whole body, if it's a fairly small organism,  
17 is that not something that could be done? Why do you  
18 need to do a tissue specific resonance?

19 **MR. SAPPINGTON:** I was specifically  
20 raising that in the context of the avian reproduction  
21 test where we, where the guideline at least is forward  
22 thinking enough to say, look, you have a highly  
23 hydrophobic compound, in this case defined log KOW  
24 three or higher, then it's recommended you measure the  
25 compound in at least one tissue but it doesn't specific

1 the tissue and I'm not sure for Dr. Hickie's question  
2 whether it specifies a treatment level or not but I can  
3 check it out, so it was picking up on the  
4 recommendation that for larger organisms whole body may  
5 not be the right metric but for something like a five  
6 or eight centimeter fish, it can be pretty challenging  
7 to dissect out ovaries and things like that.

8 **DR. NORSTROM:** I would agree if it's for  
9 bird that liver would probably be the thing you would  
10 choose for almost everything.

11 **DR. HEERINGA:** Not seeing any additional  
12 comments at this point in time, I think that hopefully  
13 that we have addressed these questions, last follow up,  
14 I think was very useful, at least to my interpretation.  
15 I appreciate the contributions. At this point I think  
16 I would like to move on to charge question number  
17 seven, on long range transport potential. Dr. Brady,  
18 if you could read that into the record, please.

19 **DR. BRADY:** Okay, charge question number  
20 seven. Screening for long range transport potential.  
21 For some pesticides with PBT characteristics, long  
22 range transport has been well documented. Currently  
23 OPPs ecological risk assessment process relies heavily  
24 on monitoring data for assessing long range transport  
25 concerns. However, this process does not a priori

1 screen for long range transport potential prior to  
2 pesticide release in the environment.

3 Difficulties in linking local use  
4 patterns of pesticides to far field deposition and  
5 exposure in a modeling framework is considered a major  
6 challenge in screening and assessing long range  
7 transport potential. Please comment on the strengths  
8 and limitations of available tools for screening long  
9 range transport potential of pesticides.

10 **DR. HEERINGA:** Before we turn to Dr.  
11 Bidleman, just a note I mentioned after the lunch  
12 break, Dr. Cohen who was a public presenter yesterday  
13 has submitted additional written comment during the  
14 period of our deliberations and so that may be  
15 considered as you choose of course during your  
16 commentaries and with that I'll turn to Dr. Bidleman,  
17 who is the lead discussant.

18 **DR. BIDLEMAN:** Well, thank you, Dr.  
19 Brady, for reading this out for us. These are the  
20 deliberations of our sub-panel, myself, Staci Simonich,  
21 Louis Thibodeaux, Jay Gan, and Tammo Steenhuis, and you  
22 can read a summary of the charge to the panel below.  
23 Let it be noted at this point that the long range  
24 transport can include both air transport, which is  
25 mostly what we'll be talking about, but it also can



1 include water transport or both.

2                   So the first thing we had to wrap our  
3 heads around when we thought about this was what do you  
4 mean when you say long range?

5                   I was at a workshop in the Netherlands a  
6 few years ago where we discussed this topic and one of  
7 the European colleagues told me in all seriousness that  
8 he considered long range to be anything over fifty  
9 kilometers. I said oh gee, I drive that far to work  
10 every day so I think we first need to say something  
11 about what we mean by long range transport here. Can  
12 you flip to the next one please?

13                   In the case of air there's a number of  
14 documented cases where we can consider long range or  
15 meso scale transport. Considering the US for example as  
16 a source, it's been quite well documented that the  
17 southern end of the US can contribute contaminants to  
18 the Great lakes and this may be a transport of a few  
19 hundred kilometers. Going farther afield we can move  
20 chemicals up to Canada and the Arctic and it's even  
21 possible to transport contaminants across the ocean to  
22 Europe.

23                   On the other hand if we want to be  
24 protective of ecosystems, we don't necessarily have to  
25 move chemicals very far to have them show up where

1 they're not wanted. A good example is simply moving  
2 chemicals from urban and agricultural areas to high  
3 elevation ecosystems in which case we're talking about  
4 a fairly short range transport but nonetheless a  
5 transport that results in chemical getting to a remote  
6 ecosystem.

7           On the recipient side, the phenomenon of  
8 trans-Pacific, that is from Asia to the US, has been  
9 documented. Canada sends contaminants down to the US,  
10 Glacier National Park and contaminants in the Great  
11 Lakes are some examples. It's possible to move those  
12 from Mexico up to the US and the actual, the first long  
13 range transport studies in the literature for  
14 pesticides were on the tradewinds from Africa to the  
15 southeastern United States and the Caribbean back in  
16 the late 1960s so here we have a very wide range of  
17 transport distances which we could consider long range  
18 but some not so long range.

19           When you look at the empirical evidence  
20 the best example, of course, are organo chlorine  
21 pesticides the classic pops like HCHs and DDT and  
22 chlordane, toxifene, et cetera and there's many studies  
23 that show that these things are truly global pollutants  
24 with transport all the way from the Great Lakes to the  
25 Arctic and the Antarctic and all points in between.

1 There's also been documentation of currently used  
2 pesticides. This CUPS is a Canadian acronym for  
3 current use pesticides in ambient air and deposition in  
4 temperate North America and Europe and there have been  
5 a number of studies on these that go back a while.

6 More recently the occurrence of both  
7 currently used pesticides and organo chlorines in air  
8 and deposition from North American mountains in  
9 particular the Sierras and the Rockies that have been  
10 several papers, some of them quite recent.

11 Going farther afield, currently used  
12 pesticides have been identified in the Arctic in the  
13 air, snow, ice, sea water, lakes in a number of  
14 different studies and transpacific transport of both  
15 currently used pesticides and organo chlorines has been  
16 documented.

17 In the case of long range transport by  
18 the oceans there are far, far, fewer data but this is  
19 now being considered a viable mechanism although on a  
20 much slower time scale if you have a chemical which is  
21 persistent in water and it becomes deposited in the  
22 ocean either by river rain input or by atmospheric  
23 deposition followed by ocean transport, if the chemical  
24 doesn't degrade, it can go a long way although it may  
25 take a decade or more to get from the temperate

1 latitudes up to the Arctic.

2                   This has been documented for  
3 hexachlorocyclohexanes in particular transport through  
4 the Pacific Ocean to the Beaufort Sea. Currently used  
5 pesticides have been found in the water of the eastern  
6 Canadian Archipelago. At this point we don't know  
7 whether that is direct ocean transport or direct  
8 atmospheric deposition to the water in the Archipelago.

9                   There are other chemicals that are  
10 suspected to be transported by ocean currents,  
11 fluorochemicals being one of them so this is a rather  
12 new kid on the block, this concept of ocean transport  
13 but it is growing especially for persistent chemicals.

14                   How to make the assessment of long range  
15 transport? Well, the easiest way is to certainly go by  
16 the two day degradation half life that is used now in  
17 most international regulations that identify persistent  
18 chemicals and the CTAC multi-media partitioning working  
19 group noted that at a windspeed of about four and a  
20 half meters per second if you keep this up for two  
21 days, you can move the chemical or half the chemical  
22 almost eight hundred kilometers.

23                   This of course is a very crude way to  
24 assess long range transport because there's several  
25 things that happen between here and there and there's

1 been a number of fugacity based models which consider  
2 transport through the air as well as ocean currents.  
3 Air soil and air water exchange especially for volatile  
4 chemicals. Particle deposition both by dry deposition  
5 and by precipitation and degradations in air, soil and  
6 water.

7           The next step in complexity would be the  
8 meteorologically based models. These would be Valerian  
9 or La Grange and air transport models which use real  
10 time meteorology. These are quite sophisticated. They  
11 require much more user sophistication and often much  
12 more computer time so I won't be dealing with these  
13 today. I'll simply be talking about the fugacity based  
14 type models and the outputs of these fugacity based  
15 models are characteristic transport distance or  
16 characteristic travel distance. This is a distance  
17 over which the air concentration drops by sixty-three  
18 percent, so you go through one CTD, you have  
19 thirty-seven percent of the chemical left.

20           Overall persistence is simply a steady  
21 state residence time with respect to degradation and  
22 transfer efficiency which is the ratio of the  
23 deposition flux from the air to the surface media in  
24 the target region divided by the continuous emission  
25 flux in the source region.



1 Frank Vonya's group has been very active  
2 in popularizing another output, and that is the Arctic  
3 contamination potential or similarly a mountain  
4 contamination potential from global pop. And the arctic  
5 contamination potential is simply the mass of chemical  
6 in the Arctic divided by either the mass or emission in  
7 the global environment. So these are all metrics that  
8 are outputs of these models that can be used to assess  
9 long range transport.

10 Here is an Arctic contamination  
11 potential map from two recent papers, one is by Chub,  
12 et al and the other's by Brown and Vonya, both are very  
13 recent ES&T papers and they simply show the  
14 partitioning space defined by two PKM properties, log  
15 KAW which is the air water partition co-efficient and  
16 log KOA which is the octanal air partition co-efficient  
17 and they show how within this chemical space, you can  
18 place chemicals that have...that are known Arctic  
19 contaminants and that's these little group of white  
20 dots in here and the closer your new chemical would  
21 come to where these other dots are would be an  
22 indication that at least has the right PKM properties  
23 to reach the Arctic.

24 You can also use this type of chemical  
25 partitioning space to classify chemicals by where they

1 end up in a multi-media model and how they get there.  
2 For example, this again is a LOG KO, KAW, the air water  
3 partition co-efficient on the Y axis and the octanal  
4 air partition coefficient here on the X axis so  
5 chemicals going down this way like to partition into  
6 the water, chemicals going this way like to partition,  
7 oh, you can't see what I'm doing with the arrows, I'm  
8 sorry. I'm too used to driving this...I've been  
9 pointing to things and...

10 **DR. HEERINGA:** I did the same thing with  
11 my students the other night so don't feel bad. I  
12 actually wrote on the screen of a computer with a magic  
13 marker.

14 **DR. BIDLEMAN:** Okay, air water partition  
15 co-efficient and chemicals going down this way like to  
16 partition into the water more favorably. KOA is the  
17 octanal air partition co-efficient and chemicals going  
18 in this direction have an increasing affinity for the  
19 octanal phase or for the lipid phase or a decreasing  
20 potential to go into the water phase if you will.

21 So the chemicals that are up here in  
22 this corner tend to end up in the atmosphere, the  
23 chemicals that are down in this quadrant would end up  
24 in sea water and fresh water, they're the water lovers.  
25 The chemicals over here would like to end up in the

1 soil and sediments and the chemicals here in green are,  
2 we call them multi-media chemicals. Those are the ones  
3 that are the most fun because they partition between  
4 the different media.

5           So in terms of how they get there, how  
6 they move around, they have been classified into  
7 flyers, swimmers and hoppers. The flyers are  
8 transported through the atmosphere, they're fairly  
9 volatile chemicals, they don't like to deposit, they  
10 mostly just stay in the air.

11           The swimmers have a high affinity for  
12 water and so you might expect river rain transport,  
13 ocean current transport to be important for these  
14 chemicals and then the rest of them are hoppers but  
15 they're classified into multi-hoppers and single  
16 hoppers. The single hoppers are mainly chemicals that  
17 have a high KOA or a low Henry's law constant or both.  
18 They tend to be on particles. So they will get  
19 suspended into the air by dust, by particle emissions,  
20 and they'll be transported as particles and when they  
21 come down they're not likely to come back up again.

22           The multiple hoppers are the ones that  
23 we call the grass-hoppering chemicals that undergo  
24 cycles of deposition, re-volatilization deposition,  
25 re-volatilization on their way from here to there, so

1 the nice thing about these chemical maps is that they  
2 show you at least roughly where the chemical's likely  
3 to end up at least in a multi media partitioning system  
4 and how they're going to get there.

5           The CTAC working group on Multimedia  
6 Partitioning and Overall Persistence and Transport  
7 Potential, that's a long name for a working group, put  
8 out or is putting out a book chapter which compares  
9 several of these multimedia fugacity modeling  
10 techniques and they've actually referenced a number of  
11 other papers which have already done the comparisons.  
12 One of the ones is Cotrin Finner et al, in ES&T 2005,  
13 there have been other ones before that and more recent  
14 than that.

15           Finner actually compared nine multimedia  
16 models for over 3000 hypothetical chemicals. They  
17 picked the hypothetical chemicals because they wanted  
18 to cover a wide range of physicochemical properties and  
19 it was easier just to make them up than to actually  
20 find chemicals with those properties.

21           So they went through this exercise and  
22 they compared the nine multimedia models for predicting  
23 characteristic transport distances and overall  
24 persistence.

25           And they noted that there were absolute

1 differences among the models, in some cases quite large  
2 absolute differences, but the multimedia models tended  
3 to rank the chemicals in the same way so if model  
4 number one would rank the chemicals A, B, C, D, E, then  
5 model three would also rank the chemicals A, B, C, D and  
6 E even though the absolute values of CTD and overall  
7 persistence would vary depending on the particular  
8 model.

9           They noticed that there was a difference  
10 between models that were mainly transport oriented.  
11 That is they...their main outputs were these two  
12 param...this particular property and target oriented,  
13 for example, ones like global pop or Arctic  
14 contamination potential which the main output is the  
15 amount of material deposited in a particular location.

16           They also noticed that there was a  
17 difference in general between global pop and the other  
18 eight models, and those differences were largely  
19 because global pop is a non-steady state model, it has  
20 variable OH radical concentrations, it has variable  
21 temperature, it has variable precipitation, whereas all  
22 the other models were steady state, they had a fixed OH  
23 concentration, fixed temperature, fixed rainfall rate,  
24 et cetera.

25           The conclusion of the paper, and I think

1 it's an important conclusion, is that all nine models  
2 when used in the correct context provide credible and  
3 useful descriptions of the complex interactions between  
4 the environment and chemical pollutants. The key  
5 phrase of course is when used in the correct context.

6           The other studies that were summarized  
7 by the CTAC working group came up with similar results  
8 and the conclusion are that multimedia box models are  
9 appropriate tools to rank chemicals and their  
10 persistence on long range transport potential, that is  
11 to rank the chemicals, not necessarily provide accurate  
12 numbers for CTD but to rank the chemicals according to  
13 their potential.

14           They also made the comment that on the  
15 time scale of days to weeks, the air flow used in the  
16 models leads to transport of chemicals along  
17 trajectories that are faster than the long term average  
18 of the mixing implied in the box models.

19           I'm still having a hard time figuring  
20 out what they're saying here, but I think what they're  
21 saying is that you can get event transported, that you  
22 can get event transported, transport events which can  
23 be quite significant which might not necessarily be  
24 picked up by the models and this is one reason why if  
25 you go to additional levels of sophistication is that

1 using a meteorologically driven model to capture event  
2 transport might be worthwhile.

3           With that very, very long introduction,  
4 we were tasked with saying something about the OECD  
5 screening tool. This is a level three fugacity model,  
6 it's a steady state, the outputs are characteristic  
7 transport distance, overall persistence and the percent  
8 transfer efficiency.

9           The compartments in the model are fixed,  
10 we have a hundred meters of ocean surface water,  
11 seventy percent of the globe, you have soil at ten  
12 centimeters depth for thirty percent of the globe and  
13 you have a six thousand meter column of air. There's  
14 no fresh water and no ground water and no sediment in  
15 the model.

16           The input parameters are octanal water  
17 partition coefficient and octanal and air water  
18 partition coefficient and three first order degradation  
19 rate half lives for soil, water and air. Now these are  
20 fixed inputs, although you can change their values,  
21 they are fixed during the transport modeling and it's  
22 run at a constant temperature of twenty-five degrees  
23 and rainfall is continuous so I mean, it's, you can see  
24 it's unrealistic but it might be useful for ranking  
25 chemicals, right, which is what it's supposed to do.

1           The people who developed this tool have  
2 a couple recommendations and one is that you perform a  
3 Monte Carlo analysis of model results which will give  
4 you a measure of the uncertainty due to the  
5 uncertainties in the chemical property's data and the  
6 degradation rates that you put into it and the other is  
7 that you don't interpret the results on an absolute  
8 scale but use it to rank chemicals.

9           So we're getting, we're getting the  
10 message here from the CTAC working group, from Cotrin  
11 Finner and from the people who develop the OECD  
12 screening tool, but what we're using these models for  
13 is not to really say chemical X is going five thousand  
14 kilometers but to say chemical X is going twice as far  
15 as chemical Y.

16           Okay, how about the real world, what is,  
17 what are all the monitoring data telling us about long  
18 range transport and can we relate it to CTD?

19           One of the earlier data sets that was  
20 used for this purpose was a set of passive air samplers  
21 that was deployed from Costa Rica up to the Canadian  
22 Arctic by Frank Vonya's group in 2000-2001, they were  
23 XAB columns that were exposed for a year so they  
24 integrated the air concentration over a full year, you  
25 know, one sample, one measurement, and that represents

1 the year's exposure for that particular site and from  
2 the gradients of air concentrations they were able to  
3 extract empirical estimates of characteristic transport  
4 distance.

5 Quite interestingly the rankings of  
6 those CTDs agreed quite well with three long range  
7 transport model results, and the absolute values of the  
8 CTD is different from the models in some cases, and  
9 they were close in some other cases but the rankings  
10 agreed well with the output of the transport models.

11 A somewhat similar study was done by  
12 Derrick Muir and coworkers, published in Environmental  
13 Toxicology and Chemistry, where they collected water  
14 samples from lakes running from upstate New York up in  
15 through southern Ontario and up into the Canadian  
16 Arctic, and in this case they were interested in  
17 current use pesticides and again they extracted  
18 characteristic transport distances from the gradients  
19 and concentrations in these lakes and they noted that  
20 there were some differences, in some cases substantial  
21 differences, between the CTDs that were empirical and  
22 the CTDs that were predicted by essentially the same  
23 models that were used up here.

24 But they got better agreement, on an  
25 absolute scale they got better agreement if they

1 allowed the model to vary the OH radical concentration  
2 because as you go northward, the concentration of OH  
3 radicals decreases and so your atmospheric lifetime due  
4 to OH degradation becomes longer and they introduce  
5 intermittent precipitation. It didn't rain all the  
6 time. I can only think that these normal models must be  
7 really, really dreary because they operate under  
8 conditions of a constant drizzle.

9           If you introduce intermediate  
10 precipitation, they got better agreement so this is an  
11 indication that in order to make models more realistic  
12 in an absolute sense we need to allow the environmental  
13 parameters to vary according to geography.

14           There was some measuring and modeling of  
15 PBDEs and PCBs in lake sediments, again going from  
16 northern New York to the Canadian Arctic. Most models  
17 overestimated the mobility and from this information  
18 Newt Revick and coworkers determined that there were  
19 key processes which needed to be included into the  
20 models. The forced filter effect, the effect that when  
21 you move a chemical cloud over the Boreal Forest you  
22 get scavenging by the forest filter effect and that's a  
23 function of the physical properties of the chemical.

24           Intermittent rain, particle deposition  
25 needs to be improved, the parameterization of particle

1 deposition needs to be improved and the photolysis of  
2 the chemical in the sorbed state, which is likely to  
3 occur they felt for PBDEs.

4           Now these models in general consider  
5 that once the chemical is onto a particle, it is there,  
6 it does not degrade and we know that for some chemicals  
7 that's simply not true.

8           So there's clues here by looking at the  
9 outputs of the models and the real world estimates of  
10 how we might be able to improve the models in the  
11 future and this is really the beauty of environmental  
12 measurements used in synergy with modeling. The two  
13 just work hand in hand.

14           Okay, there's some things that we know  
15 about currently used pesticides that are different from  
16 the classic pops and we should be including them into  
17 the models. One is the particle gas partitioning. We  
18 know that for organo-chlorine pesticides and PCBs this  
19 partitioning between the particle and the gas phase is  
20 well described by either KOA or by vapor pressure.  
21 This is just not true for most currently used  
22 pesticides.

23           There has been a number of studies now  
24 that show that the CUPs are more strongly sorbed to  
25 mineral matter, they're more affected by aerosol water

1 content, and that the simple Yona Pankow model or the  
2 KOA model in general just does not work.

3           There's something new on the horizon.  
4 It's referred to as ppLFERS, or polyparameter linear  
5 free energy relationships which take into account not  
6 only hydrophobic interactions with the particle which  
7 you would get with the pops but also things that would  
8 be more important for the polar pesticides like  
9 hydrogen bonding and electron donor acceptor  
10 interactions and by using these types of descriptors we  
11 can get a more accurate picture of the particle gas  
12 partitioning of currently used pesticides than by using  
13 the older models.

14           Many, many more data sets are becoming  
15 available for which we can test models. There are  
16 Arctic sampling campaigns which are simultaneously  
17 measuring contaminants in source regions and at all the  
18 circumpolar Arctic sites, this is a so called NCPA  
19 program that's part of the international polar year.

20           There are passive air sampling campaigns  
21 being conducted on a continental scale, on a global  
22 scale. For example, the global atmospheric passive  
23 sampling campaign so that within the next few years  
24 we're going to see an explosion of data.

25           We've already seen some of it coming

1 out, for example, these two papers in ES&T for which we  
2 will have a lot more empirical data against which to  
3 test these characteristic transport distance models so  
4 I'm hoping that someone will pick up the ball in the  
5 future and use this as a wonderful opportunity to  
6 compare the measured and model CTDs, improve the models  
7 and give us a better indication of where new chemicals  
8 are going to go.

9           So we have some recommendations on  
10 persistence and long range transport. The first  
11 recommendation is that we employ a tiered approach for  
12 assessing long range transport potential. Tier one is  
13 simply to look and see if your predicted or measured  
14 atmospheric degradation half life is greater than two  
15 days. If it's greater than two days, then use  
16 something simple like the OECD screening tool and  
17 compare the outputs to the chemicals we already know  
18 are undergoing long range transport.

19           If the answer here comes out yes, then  
20 go to more sophisticated models to assess long range  
21 transport. So I think using these three in a tiered  
22 approach. This potential for long range transport  
23 should be proactively assessed during registration. We  
24 don't want to let a chemical out the door and have to  
25 wait for ten years to find out if it's going to show up

1 in the Arctic and this potential for long range  
2 transport should be included in the overall risk  
3 characterization of pesticides and other new chemicals.

4 We need improvements in the long range  
5 transport model parameters to accommodate the special  
6 requirements of currently used pesticides which are by  
7 and large more polar than the classic pops. Particle  
8 gas partitioning is not simply described by the older  
9 models, we should consider new ways of looking at that  
10 partitioning in our models.

11 We need investigations of the  
12 degradation of currently used pesticides once they're  
13 sorbed to particles. Let's not assume that they just  
14 sit there on the particles and are not affected, they  
15 very well may not be and we need to recognize that the  
16 atmospheric oxidation potential program works well for  
17 PCBs and for PAHs but it may not be accurate for  
18 complex molecules like CUPs, and we need more  
19 experimental measurements of the OH radical reaction  
20 rates. This doesn't come directly from us, this comes  
21 from Roger Atkinson, arguably the God of OH radical  
22 reactions.

23 And finally, measurements and modeling  
24 need to be improved to assess the long range transport  
25 potential of pesticides via ocean currents. This whole

1 area is just in its infancy right now. And lest you  
2 thought we were done and you think we might be  
3 considered over-achievers, there was another issue that  
4 was on the agenda. It wasn't specifically framed as a  
5 question, but it was this statement here. The  
6 difficulties of linking local use patterns to far field  
7 deposition exposure is considered a major challenge.

8           So we decided to say something about  
9 this as well. Linking the exposure from long range  
10 transport implied to us that we need to go beyond the  
11 simple ranking of chemicals but we need to come to a  
12 point where we can make quantitative estimates of  
13 pesticide emissions and source regions and connect  
14 those to long range transport. So that's a step beyond  
15 simply ranking them according to their transport  
16 potential.

17           Next one please, there we are. So how  
18 do we get chemicals off a site? Well, there's spray  
19 drift during application, there's precipitation which  
20 can deliver the runoff into a pond or a stream or an  
21 estuary from which it could either stay there or  
22 volatilize. There's direct volatilization from the  
23 soil during and after applications, during and after  
24 rainstorms and during dry periods you can get soil dust  
25 which is entrained and carried long distances.



1 Next one, please. The volatilization is  
2 a very important process for moving a volatile  
3 pesticide. This could be a fumaGEN or it could be even  
4 something like DDT which is sufficiently volatile to  
5 undergo this process.

6 It depends on the properties of the  
7 chemical, it depends on the formulation, how it's  
8 applied, whether it's a foliar spray, whether it's  
9 applied to the soil surface, whether it dips into the  
10 soil. The soil characteristics, how much you mix up  
11 that soil, either by earthworm mixing or by going and  
12 plowing it twice a year, and it depends very much on  
13 the micro-meteorology of the specific situation.

14 Next one, please. So we have to  
15 recognize that long range transport really begins at  
16 the source. All transport models rely on estimates of  
17 source emissions. There's a number of ways that the  
18 models get those source emissions. Some estimate them  
19 from the quantity of pesticides applied.

20 You don't necessarily need to know the  
21 absolute source emission amount to rank the chemicals  
22 for long range transport potential but if you want to  
23 actually say how much of a chemical is undergoing  
24 transport and how much of it is going to deposit, then  
25 you need to know the mass of chemical mobilized or

1 transported. You need to know the emission factor.

2 For our LRT models these are sometimes  
3 estimated from usage data as I stated above or they can  
4 simply be generic. You stick into the model at a  
5 hundred tons per year as being used. Some long range  
6 transport models use actual soil to air emissions data  
7 either mod...you know, which is usually modeled on  
8 regional scales. Here's two La Grangian transport  
9 models which have done that.

10 A key step in getting accurate emissions  
11 data is to consider what happens when the pesticide is  
12 in the soil, undergoes volatilization and mixes up into  
13 the air boundary layer which is on the order of a  
14 couple of meters or so above the soil. Once you get it  
15 up here, now you start your long range transport but  
16 you've got to get it to this point first.

17 There have been quite a few models that  
18 have been developed to do this, of various  
19 complexities, some of these are indeed very complex  
20 models. Some of them you need to dry with real  
21 meteorology because that affects how this flux varies  
22 during the day.

23 We need to improve those models by  
24 revisiting some of the underlying theories in the mass  
25 transport correlations that get the pesticides out of

1 the soil and into the air boundary layer so that we can  
2 transport them. This used to be a popular thing to do.  
3 Back in the 1970s through the early 1990s there were  
4 many experiments done to actually measure pesticide  
5 fluxes from fields. Most of these were done with  
6 organo chorines but some were done with currently used  
7 pesticides also.

8           A few of these experiments have actually  
9 been modeled but not many, but those that have been  
10 modeled generally show pretty good agreement between  
11 the emission models and the actual measured fluxes. We  
12 are suggesting that it might be possible to go back to  
13 some of these old flux measurements and mine the data  
14 and model them and improve the modeling capability and  
15 the confidence in the models for predicting pesticide  
16 emissions from treated soils.

17           If we could do that, then we might be  
18 able to extend those soil air models to regional scales  
19 using GIS land cover and pesticide use data to  
20 generalize emissions so that we could extend these  
21 transport models to predicting actual quantities which  
22 are mobilized and moved to remote areas. So, thank  
23 you.

24           **DR. HEERINGA:**       Thank you very much, Dr.  
25 Bidleman, a very comprehensive review. On the last

1 issue I know that the SAP has actually looked at some  
2 of those flux measurements with local meteorological  
3 modeling in relation to fumigants and particularly in  
4 the Central Valley so that's...

5 **DR. BIDLEMAN:** I know a lot of work has  
6 been done with fumigants and that's great, but they are  
7 in general different from most of the pesticides.

8 **DR. HEERINGA:** Sure, okay, well, we have  
9 other associate discussants on this, and I guess I'm  
10 sure everybody contributed to this presentation but  
11 have the chance to contribute additional information or  
12 comments, Dr. Simonich?

13 **DR. SIMONICH:** I have nothing to add to  
14 Dr. Bidleman's excellent summary.

15 **DR. HEERINGA:** Dr. Thibodeaux?

16 **DR. THIBODEAUX:** Thibodeaux. That was  
17 too easy. We got our act together, but I do have a  
18 question. How do you do it now? In other words  
19 localize to start the emissions that Terry was talking  
20 about in your current scheme and I was looking back  
21 through some of the papers and data, does PRZM have a  
22 reposition compound?

23 **DR. HEERINGA:** Dr. Hetrick?

24 **DR. HETRICK:** Yes, PRZM can estimate  
25 volatilization flux and what's nice about that is you

1 can actually look at that flux as a function of  
2 different management practices so soil incorporation  
3 would be included, things of that nature.

4 **DR. HEERINGA:** Good, thank you. Dr.  
5 Gan?

6 **DR. GAN:** Very good job, Terry. As a  
7 chemist I just tend to think, you know, what's the  
8 trigger for the LRP definition? With advancement in  
9 chemistry, you know, the likelihood of us finding these  
10 chemicals at very low levels in, it doesn't matter  
11 where it is, will increase and you know, if you see  
12 something at a very low level will that qualify for  
13 that chemical to be called LRP compound? Just  
14 something to think about I think.

15 **DR. BIDLEMAN:** This was actually a  
16 question that was raised in the CTAC workshop by  
17 somebody who didn't phrase it as nicely as you, he said  
18 you know, you analytical chemists are pretty smart, you  
19 guys can look for nothing in everything. What does it  
20 mean when you find a nanogram in water of the Arctic  
21 and it's a good point.

22 Does a simple detection of a chemical in  
23 a remote region trigger an outcry? Do you somehow  
24 have to connect it with potential toxicity? It's a  
25 question that everybody has an opinion but nobody

1 really has a definitive answer. I'm not sure there is  
2 a definitive answer.

3           It's, I would say one of the key points  
4 is to note where that chemical's increasing or  
5 remaining constant or decreasing. If a chemical is  
6 present at a low level but over the years it's  
7 increasing, to me that would send a red flag that we  
8 need to start thinking about why. But you're right,  
9 it's something that we're not going to answer here but  
10 I think needs some more discussion.

11           **DR. HEERINGA:**       Dr. Steenhuis also an  
12 associate discussant with this group.

13           **DR. STEENHUIS:**       I only would like to  
14 point out the total distances are important, well, play  
15 a role in this equation, too. I think, coming from the  
16 Netherlands, that fifty kilometers is a long way. It's  
17 half across the country. Moreover, it drizzles always  
18 down there, it is a dreary country so I have  
19 nothing....

20           **DR. BIDLEMAN:**       I said the workshop was  
21 in the Netherlands, I didn't say that the person was in  
22 the Netherlands.

23           **DR. HEERINGA:**       Yes, Dr. Thibodeaux.

24           **DR. THIBODEAUX:**       Thibodeaux. So the  
25 emissions, I'm talking about air from the PRZM, is that

1 used in any way in looking at ecological risk in the  
2 near field like around the farm plot?

3 **DR. HETRICK:** Currently we're not using  
4 that aspect of the PRZM model. It's something we're  
5 exploring and, but we're not using that currently in  
6 our exposure assessments.

7 **DR. THIBODEAUX:** It seems strange to me,  
8 I was talking to Willie Lick at the break and he says,  
9 there he is, sitting in his office at his house and  
10 here comes this helicopter, spraying on the avocados  
11 and when I go to my mom's old place where there's a  
12 rice farm, right after the rice is planted there are  
13 planes all in the air.

14 **DR. HETRICK:** Let me try to elaborate a  
15 little bit more on this. I'm getting my colleagues  
16 here throwing stuff at me, but the bottom line is that  
17 we do look at spray drift so we do consider that.

18 But as far as, and we are going to  
19 probably evaluate the PRZM model a little more  
20 extensively for volatilization in an upcoming SAP that  
21 we're going to do on volatilization so that may  
22 actually take us into a little more of a quantitative  
23 assessment as to what's going on there but currently  
24 the volatilization sub routines in PRZM are not used in  
25 a routine manner in our exposure assessments.

1                   **DR. HEERINGA:**       Dr. Portier.

2                   **DR. PORTIER:**       I bet you thought I was  
3 sleeping, right? One of the things we haven't talked  
4 about here is somewhere in between near field which is  
5 in, measured in meters or tenths of meters and hundreds  
6 of kilometers, that there's that Ag to urban or Ag to  
7 suburban transformation that most people are really  
8 interested in.

9                   What happens in that rice field shows up  
10 in my living room carpet and I'm wondering where does  
11 long range transport... I'm probably crossing  
12 disciplines here because there's probably a bunch of  
13 chemists who look hundreds of kilometers and EPA looks  
14 the field and next to the field and I don't know who's  
15 looking at that other kind of, maybe our USDA person  
16 could answer that.

17                   **DR. HEERINGA:**       Linda.

18                   **DR. ABBOTT:**       Linda Abbott. Actually I  
19 was going to say this in response to the question eight  
20 but we can get it out of the way now. USDA is looking  
21 at that issue, and I wanted to alert the Agency to a  
22 program that's being conducted by USDA and that  
23 conservation evaluate....the conservation effects  
24 assessment program where we're trying to link together  
25 models to look at short and long range transport, not



1 specifically of pesticides but of sediments and in some  
2 of the watersheds we are looking at pesticides. Now I  
3 think that's all I'm going to say at this moment  
4 because this comment actually fits better with question  
5 eight. I don't want to open that up.

6 **DR. HEERINGA:** Thank you. We'll get  
7 back to that. I think we'll have opportunity certainly  
8 on Ken's question too in relation to question...charge  
9 questions nine and ten. Dr. Hickie, you look  
10 anticipatory. Did you have...

11 **DR. HICKIE:** This is a question for  
12 Terry, number one is, I was typing away, did you  
13 mention back trajectory analysis and how it might be  
14 used?

15 **DR. BIDLEMAN:** I did not mention back  
16 trajectory analysis because it really wasn't part of a  
17 modeling, it was part of the evaluation of monitoring  
18 data, but certainly this is something that virtually  
19 everybody is doing anymore, they're either looking for  
20 a single event air samples, they're looking at back  
21 trajectories for those event air samplers or for  
22 passive samplers which sit out there for a week or so,  
23 they're developing air shed maps which basically tell  
24 you where the....what the probability was of the air  
25 coming from a certain region and those can be even

1 further extended into something called source area  
2 impact factors. Is that right, Staci? Source area  
3 impact factor?

4 **DR. SIMONICH:** Source region impact  
5 factor.

6 **DR. BIDLEMAN:** Source region, yes. So  
7 there's a way of, yes, of evaluating this. In the case  
8 of pesticides which have aerial sources A-E-R-I-A-L,  
9 not arial up there, but aerial like spread over a wide  
10 area. You don't have a point source, your chemical  
11 could be emitted anywhere from where the trajectories  
12 started out to where they actually ended up.

13 And I used to show a very nice example  
14 of a very high toxifene measurement we made when I was  
15 in South Carolina and the air parcel went straight back  
16 to Alberta, and I used to tell people it was a perfect  
17 example of Canada sending toxifene down to the southern  
18 United States. Of course it wasn't.

19 It was all of the land, you know, over  
20 which the trajectory passed on its way down there that  
21 probably picked up toxifene emissions so I think they  
22 have to be used with cautions but in the case of trying  
23 to say what general region the air passed over there,  
24 they are quite valuable.

25 **DR. HEERINGA:** Dr. Hickie.

1                   **DR. HICKIE:**       Second unrelated question,  
2 but I just wonder you mentioned the ppLFERS, do you  
3 know if anybody's using those to look at water to  
4 particle partitioning?

5                   **DR. BIDLEMAN:**       Yes, actually Kye Goss's  
6 group, Martin Sherringer's group, the whole group in  
7 Switzerland has been using these. They have used  
8 polyparameter linear free energy relationships to look  
9 at sorption to particles of all kinds, they've looked  
10 at sorption to hemic acid, sediments, et cetera, yeah,  
11 they're generally applicable.

12                  **DR. HEERINGA:**       Dr. Mehta has a comment.

13                  **DR. MEHTA:**       Right, you, I'm not sure if  
14 you...you mentioned oceans but did you also mention  
15 estuaries or...

16                  **DR. BIDLEMAN:**       We did not mention  
17 estuaries, although obviously to get the chemical out  
18 of the river into the open ocean you need to cross an  
19 estuary. The descriptions of ocean transport over a  
20 long distance are not that sophisticated.

21                               In fact the whole treatment of the  
22 oceans and the ocean currents for moving chemicals over  
23 long distances is not all that well described and it's  
24 being evaluated more now but there's a question for  
25 chemicals that are primarily moved through the

1 atmosphere whether the riverine input is all that  
2 important or whether it's mainly atmospheric deposition  
3 into the open ocean followed by transport.

4           While the, you know, there might be  
5 significant loadings in the rivers, there's a whole  
6 huge area of ocean available for atmospheric deposition  
7 and maybe a situation like the Great Lakes where, you  
8 know, PCB input was assessed and it was found that the  
9 atmospheric deposition greatly outweighed the riverine  
10 input.

11           **DR. MEHTA:**       The reason why I was asking  
12 is that you do have sorbed chemicals on fine particles  
13 then the, I'm speaking about the process of aggregation  
14 of particles in water and there are three mechanisms.  
15 One is ground in motion which is not that important  
16 but, and the essential settling where, you know, where  
17 you have flat water then particles fall, they hit each  
18 other and there can be aggregation.

19           But the most important one is  
20 aggregation of the sheer and there's been a fairly good  
21 advancement in science as far as modeling individual  
22 particles that grow up and break up under turbulent  
23 flows.

24           The problem comes in is that those  
25 specific models when you connect them to regular

1 estuarine transport models, the time required for a  
2 concentration purposes becomes so large that it's  
3 practically impossible to run them right now, but even  
4 then if you do use lump parameter approaches to  
5 simplify those equations and some of the work in fact  
6 is going on in San Francisco Bay and other places for  
7 tracking contamination from the packing estuaries.

8 **DR. HEERINGA:** Dr. Simonich?

9 **DR. SIMONICH:** I did think of one thing  
10 I wanted to stress was that the generic conceptual  
11 models should include atmospheric deposition to large  
12 surface area water bodies, for example, the Great Lakes  
13 and oceans.

14 **DR. HEERINGA:** I'd like to turn to Dr.  
15 Brady. I think this question has had good coverage but  
16 I'll ask you if you have any questions to follow up  
17 with the panel.

18 **DR. BRADY:** I think Dr. Khan has one or  
19 two quick, one comment and one question I believe.

20 **DR. HEERINGA:** Sure.

21 **DR. KHAN:** That's correct. First I'd  
22 like to comment on Dr. Portier's earlier comments about  
23 that, whether we ignore the far fields. That's not true  
24 either. In a case by case as the chairman already  
25 alluded to that in the fumigant we did address far

1 fields. And in other model we used, which is the AG  
2 disc Dawson extension to look at far fields, and those  
3 two models we do use some far field approach.

4           And my question is that in the two we  
5 have seen that the exercise I did for the validity too,  
6 I used very similar a structure we used for PRZM EXAM  
7 for input parameters, which we used the 90th percentile  
8 because of the large variability between the vertical  
9 values and what's the recommendation to use, because  
10 it's such a large variable I mean, what do you  
11 recommend to approach that?

12           **DR. BIDLEMAN:**       Sorry, Faruque, I didn't  
13 understand the question. Are you asking about the  
14 choice of PKM properties?

15           **DR. KHAN:**       Not PKM properties, but the  
16 soil, you know, like aerobic metabolism studies or we  
17 get those studies from the registrant and generally  
18 they have a large variable sometimes, like Jim Hetrick  
19 was talking about it yesterday, like a fifty to five  
20 hundred days.

21           **DR. BIDLEMAN:**       Right, so which one of  
22 those do you put in the model? Well, the screening  
23 tool does allow you to do a Monte Carlo analysis in  
24 sensitivity and you could also just do it manually by  
25 you know, plugging in fifty days or plugging in five

1 hundred days and seeing what difference it makes, and  
2 I'd say, you know, without knowing a whole lot more  
3 about how to choose a particular half life, that may be  
4 the best way to do it.

5 **DR. KHAN:** Thank you, and thank you,  
6 panel members, for the in depth discussion for the long  
7 range transfer.

8 **DR. HEERINGA:** Thank you, Dr. Khan. At  
9 this point we are at an appropriate place to take a  
10 break and move on certainly to question number eight  
11 following the agenda, and I haven't yet decided whether  
12 we finished with question eight whether to move on to  
13 nine, and I'll make that decision jointly with you, the  
14 members of the panel when the time arrives, so but,  
15 let's take a fifteen minute break and reconvene at 3:30  
16 and we'll move on to charge question number eight.

17 **(WHEREUPON** , a brief recess was taken.)

18 **DR. HEERINGA:** Okay, welcome back,  
19 everyone. We've completed our discussion, initial  
20 discussion of charge question seven on long range  
21 transport.

22 Thank you to Dr. Bidleman and the team  
23 of associate discussants on that, and we're set to move  
24 on to charge question number eight, and I think  
25 tentatively decided that what I would like to do today

1 is to consider charge question eight and leave nine and  
2 ten for first thing tomorrow morning, and that gives  
3 our working group a little chance to think on their own  
4 and to maybe deliberate a little bit together as a  
5 working group and we'll resume again tomorrow morning  
6 at 8:30.

7 We would be here anyway and I think  
8 rather than split those questions up, I think we'll  
9 consider them both together tomorrow morning but we  
10 will have ample time for question number eight, so Dr.  
11 Brady, if you could please read it into the record for  
12 us?

13 **DR. BRADY:** Number eight, in the White  
14 paper, the Agency describes a number of issues it has  
15 encountered when assessing persistence,  
16 bioaccumulation, toxicity, and long range transport in  
17 its aquatic and terrestrial ecological risk assessments  
18 involving pesticides with PBT profiles.

19 In addition the Agency has identified  
20 various methods and approaches that it is considering  
21 for refining its ecological risk assessment process  
22 specifically to address these PBT and LRT related  
23 issues.

24 Please comment on the extent to which  
25 the Agency has identified and characterized the unique

1 or problematic issues associated with assessing  
2 ecological risks of pesticides with PBT characteristics  
3 and the need for the Agency to incorporate refinements  
4 in the tools and methods it uses to assess ecological  
5 risks of these compounds.

6 **DR. HEERINGA:** Our lead discussant is  
7 Dr. Maddalena.

8 **DR. MADDALENA:** Okay, thank you, the  
9 co-discussants on this question, Dr. Abbott, Dr.  
10 Delorme and Dr. Oris will jump in after I run over, run  
11 through a quick series of bullets that kind of came out  
12 of conversation over the last few days, have some  
13 higher level issues identified I think that will be  
14 drilled down into in the next two questions. Nine and  
15 ten seem to go in series so next slide, please.

16 I think that was it, a duplicate, if you  
17 can go to the next one again. Thank you. So anyways I  
18 think the first thing we want to do is commend the  
19 Agency for bringing this to the panelists. This is a  
20 big and very diverse panel and I think you probably  
21 knew you were going to get hit from every direction and  
22 as far as identifying some of the unique problems  
23 associated with this particular class of chemicals, we  
24 generally thought you did a good job of that, finding  
25 those unique challenges.



1 Characterizing these challenges,  
2 although there's obviously a lot of good work that's  
3 been done there, there's some very big steps that  
4 remain that could be quite a challenge to characterize  
5 some of these very unique properties and behaviors in  
6 the environment for persisting and bioaccumulative and  
7 long range transport type chemicals not to mention the  
8 toxic part.

9 So what I'd like to kind of present or  
10 bring forward is that the challenge here in assessing  
11 PBTs is likely going to require a big frame shift in  
12 the way the OPP thinks about and frames the problem.

13 What I'm talking about is developing  
14 your conceptual model, I think there's a ways to go  
15 there and not that you have to just throw out your  
16 initial conceptual model, but there is some I think  
17 good rationale from what we've heard around the table  
18 that to step back and reevaluate what this conceptual  
19 model should look like and what the key endpoints or  
20 processes are going to be included.

21 Sure, that's a lot of work, but the  
22 encouraging thing or at least what I'd like to  
23 personally encourage the Agency to think about is that  
24 this probably isn't the first time you're going to come  
25 across nor the last time you're going to come across

1 these things that are different and a good example  
2 which may not be too far in the future are the  
3 engineered mammal materials going into the pest  
4 management stream and there's really not a lot of  
5 confidence as to whether you can drop those down into  
6 the current paradigm and get a good answer out the  
7 bottom that you could count on.

8           So in doing this, you can think a little  
9 bit broader than just dealing with PBTs and think about  
10 okay, how do we just, how do we adapt to an emerging  
11 field of chemicals in the first place and look at that  
12 as well so you can gain a little bit of bang for your  
13 buck.

14           So the next slide, I think the point is  
15 that in moving forward, the Agency is going to have to  
16 rely heavily on either new or modified models and so  
17 it's important to look at this as, almost as a model  
18 development or selection model, selection model  
19 evaluation and model application process that's pretty  
20 well described in a number of places and the most  
21 recent one, that in fact the EPA put out.

22           And I referred to it earlier, screen  
23 shot here of the guidance document, really lays out a  
24 lot. And it's a very simple, short, well written  
25 document that really lays out some of the challenges

1 and some guidelines or suggestions on how to move  
2 forward in a way that you can learn from your efforts,  
3 something that Dr. Gobas had in one of his final  
4 slides. Talked about developing a model, calibrating  
5 the model, using it, learning from it and improving on  
6 it, and that's a whole cyclic process that really  
7 doesn't end. 'Cause models, I think if you step back  
8 and realize that models are really not meant to be  
9 truth generating machines, they're tools that you can  
10 use, that it gives you another sense of how you're  
11 going to use these things as you move forward. So next  
12 slide, please.

13                   So that was kind of my only comments  
14 really on question one, do we want to go right through  
15 question two first or...

16                   **DR. HEERINGA:**     Why don't you go ahead?

17                   **DR. MADDALENA:**     Okay, I'll finish my  
18 comments anyway so question two asks about the need for  
19 the Agency to incorporate refinements in the tools and  
20 methods to use ecological risk assessments.

21                   The next slide, I think the take home at  
22 least from sitting here and it would probably be even  
23 more frightening sitting where you guys are sitting is  
24 that the suggestions and comments that you receive for  
25 refinements, yes, there are a lot of possible



1 refinements that can be made but these suggestions have  
2 gone the whole gamut of complexity.

3           From the conversation, a good contrast  
4 is the conversation on sediment dynamics at the end of  
5 the day yesterday compared to the conversation on long  
6 range transport. The details that go into these models  
7 are phenomenally different, they go a wide range of  
8 complexities, so it's going to be a real challenge to  
9 try and figure out how to deal with incorporating this  
10 information into your overall process.

11           Some of the later charge questions, nine  
12 and ten in particular, will attempt to really answer  
13 the question as far as prioritizing some of these ideas  
14 and some of the recommendations on what to deal with  
15 first, but again, just to highlight the fact that one  
16 of the important lessons here is that this assessment  
17 with the PBTs and LRT chemicals is really going to  
18 depend on models, and models depend on no known's, and  
19 one way to look at it is, you know, a value, a process,  
20 and you know how to parameterize it.

21           There's also known unknowns so you know  
22 the value of the process, you really don't know how to  
23 parameterize it but you can put a statistical  
24 distribution around it and do a pretty good job of  
25 estimating it.



1                   But the challenge is always for these is  
2 going to be the unknowns unknowns, so things you don't  
3 know that you don't know in other words, are going to  
4 surprise you and they're surprising us all the time and  
5 that's what is exciting for model developers is because  
6 when your model is wrong, you can move forward, but  
7 it's probably not nearly as exciting for you guys. You  
8 want the model to be right and done.

9                   So just a few of these issues, the  
10 inputs, the process knowledge and models and then some  
11 strategies that might move forward and again I lifted  
12 from that document I showed earlier if you want to slip  
13 the next slide.

14                   I lifted kind of a nice visual that  
15 helps you, I think helps me explain what I mean by  
16 capturing all these different levels of complexity and  
17 trying to balance the system, the ultimate, you know,  
18 the final approach that you guys decide to use really  
19 needs to take into account model complexity in terms of  
20 as you get a simple, simple model, you end up with  
21 something that really doesn't represent reality as  
22 much. It's easier to understand, easier to use, faster  
23 to use, and sometimes it's easier to refute, you know,  
24 to prove that it's wrong.

25                   But as you move over to a more complex

1 model, you get to a point where your understanding of  
2 the system doesn't quite keep up with your complexity  
3 of your model and so uncertainty is in your data and  
4 your inputs to the model might overwhelm what you gain  
5 on more resolution in your system and so these kinds  
6 of, this whole paradigm or this whole idea of building  
7 a model that balances complexities and usefulness, I  
8 guess I could say, it's going to be a challenge, you  
9 know, and to move into that area is probably my biggest  
10 recommendation for number eight and that's pretty much  
11 it. So I'll turn it over to the co-discussants on this  
12 now for a little more detail.

13 **DR. HEERINGA:** Thank you very much and  
14 Dr. Abbott is our first associate discussant.

15 **DR. ABBOTT:** Well, these chemicals  
16 because they are going to be persisting for long  
17 periods of time are probably going to create some  
18 challenges for the Agency in considering both spatial  
19 and temporal scales of exposure.

20 I briefly have two comments. First, in  
21 the White paper there is a discussion about the need  
22 for potentially looking at the exposure due to multiple  
23 applications, there are applications for many different  
24 fields within say a watershed because these chemicals  
25 are persistent, more than just looking at the simple



1 pond scenario you have, you might have input from lots  
2 of different fields and over different times.

3           So it seems as though you might need  
4 another technique to try to assess what the exposure  
5 might be from multiple applications to multiple fields  
6 over different time periods, maybe not all within the  
7 same year but within the period in which these  
8 pesticides are going to persist.

9           I really have no solution to that  
10 problem for you, I'm sorry to say, but I do want to  
11 alert you to some data and some modeling techniques  
12 that might help you in the long term, not the short  
13 term as you try to frame how you're going to address  
14 looking at multiple applications for many different  
15 fields within a watershed.

16           The Department of Agriculture about five  
17 years ago embarked on a project to try to examine the  
18 impact of implementing conservation practices within  
19 watersheds. The conservation effects assessment  
20 program and this is the question that I started to  
21 answer in response to Dr. Portier's question to me  
22 earlier.

23           But, I realized it had nothing to do  
24 with aerial transport but the Department has expended a  
25 lot of resources from many different agencies, the

1 Agricultural Research Service, the Natural Resources  
2 Conservation Service, Cooperative States Research,  
3 Education and Extension Service and the Economic  
4 Research Service just to name a few, there are other  
5 parts of USDA that are also participating in this  
6 program.

7           But where I think it might be able to  
8 help you is USDA identified over ten watersheds where  
9 we had a long term monitoring data base and we had been  
10 trying to develop models and link together or we're  
11 linking together existing models and trying to develop  
12 new modeling techniques to try to estimate the effect  
13 of installing conservation practices on water quality,  
14 air quality and soil quality.

15           And as part of that project, many of the  
16 models that you discussed in section, I think it was  
17 four in the White paper, are being tested in the field.  
18 In some of the watersheds, the ecological stressors  
19 include pesticides.

20           One watershed I can think of in  
21 particular that might be of interest to you is the one  
22 that's being worked on in Tifton, Georgia. There,  
23 they're trying to look at the effect of spatial and  
24 temporal scale on the ability of a whole range of  
25 models to predict concentrations of pesticides.

1 I'm thinking that maybe Tim Strickland  
2 or Richard Lorenz might be good contacts for you to  
3 talk to about their implementation of not just PRZM but  
4 I think they're also using EXAMS and some of the other  
5 models that you've mentioned here in section four, SWAT  
6 and AGNIPs.

7 And I'd also like to point out that I  
8 believe it's in the Mississippi watershed there's an  
9 effort to look at bank erosion and the transport of  
10 sediments from streams that are undergoing bank erosion  
11 and although I don't believe in Mississippi in that  
12 watershed they're actually looking at pesticides, just  
13 the long term transport of the sediments might be of  
14 use to you.

15 So my first comment is just that USDA is  
16 actively investigating a range of different models and  
17 looking at them over different spatial scales and  
18 different temporal scales trying to determine how well  
19 they can be used to look at sediment input into water  
20 and pesticide. They're also looking at nutrients, that  
21 may not be of much concern to you but that might be a  
22 data source or a source of collaboration.

23 Now my second comment might be more  
24 useful to you immediately. In reading the White paper  
25 and listening to the presentations here for the last

1 three days, I've been trying to think as a risk  
2 assessment practitioner, what would I want to do if I  
3 had on my desk a pile of risk assessments that had to  
4 be done say by the end of the year, maybe the end of  
5 the month, and I wanted to maximize the chance that I  
6 didn't miss an exposure that I could possibly address  
7 right now.

8                   So with that in mind, I wonder whether  
9 or not looking at current agricultural practices, not  
10 just the two exposure scenarios that I was able to  
11 identify in the White paper, but looking at a range of  
12 agricultural practices might lead you to look at areas  
13 where you might be having an accumulation of these  
14 pesticides that might not be captured by the scenarios  
15 that are discussed in the White paper.

16                   Now I'm going to assume, and I know that  
17 you probably have other scenarios that aren't in the  
18 White paper but just from my reading of the White paper  
19 there appeared to be two exposure scenarios that you  
20 look at, the one that has to, that's associated with  
21 the agricultural pond where you have the ten hector  
22 field that has runoff transported directly into a one  
23 hector, is it a one hector pond and then there also  
24 seems to be a scenario from the terrestrial side where  
25 you might be looking at accumulation of residues in the

1 treated field.

2 I'm thinking that there might be some  
3 agricultural practices that range between those two  
4 scenarios that might present a challenge that...well,  
5 they might present an opportunity for an accumulation  
6 of pesticide in an area that's not captured by the  
7 scenarios you're already looking at.

8 Now I'm assuming that with the  
9 agricultural pond that that ten hector field is all one  
10 cover type and all one soil and it flows directly into  
11 the agricultural pond.

12 I'm also thinking that maybe if you, the  
13 practice that comes to mind immediately that might have  
14 a different, that might not be captured by what you're  
15 already looking at is if you have a buffer or an  
16 untreated, not untreated, a non-agricultural area  
17 that's in between the field and the pond and I'm  
18 thinking specifically of a situation where the soil  
19 type in the non Ag area is of a different type and the  
20 cover is different than that of the adjacent field.

21 I wonder if there might be an  
22 opportunity for looking at that scenario to see whether  
23 or not you might have an accumulation of pesticide in  
24 the soil that is radically different than what's in the  
25 field like maybe a wet area or a marshy area.

1                   **DR. PARKER:**       It's actually easier to  
2 look at that accumulation in the water than it is the  
3 field itself. The field does have not only dissipation  
4 but leaching into the vadozone and the ground water  
5 plus runoff plus volatilization from the field so that  
6 the field isn't a static area with no sink, like a  
7 water body is.

8                   So, as someone pointed out if you  
9 continuously put something into a water body and you  
10 have no place for it to go then it does accumulate  
11 essentially forever so it's the half lives that will  
12 determine whether something accumulates or not, but we  
13 do and that's part of the reason that we've looked at,  
14 that we're looking at these four example chemicals is  
15 because they do tend to accumulate in our static pond  
16 and sort of looking at how do we deal with the impact  
17 of that.

18                   **DR. ABBOTT:**       Well, I guess I'm thinking  
19 of the, this untreated area not only from the  
20 standpoint of the aquatic assessment but also perhaps  
21 the terrestrial assessment. I don't know whether or  
22 not in the terrestrial assessment you look at ingestion  
23 of soil.

24                   But, I'm thinking that if there's a  
25 different soil type, perhaps more organic matter or



1 something that might change the accumulation and the  
2 persistence of these chemicals in that area that maybe  
3 that would be a different type of exposure that you  
4 could look at right now.

5                   Now I don't know if this has merit. I  
6 mean, maybe other members of the panel might want to  
7 opine on whether or not it would be worthwhile for the  
8 EPA to try to capture something in between the treated  
9 field and the pond that might be a completely different  
10 type of soil and cover that might have different types  
11 of wildlife than you would find on the field but that  
12 was one area that I thought might be something you  
13 could look at right now.

14                   The other AG practice that I wonder if  
15 it's captured in the scenarios that I saw in the White  
16 paper would be irrigation and return flow from drainage  
17 from a field.

18                   I don't know whether or not that would  
19 be radically different than what you're looking at as  
20 coming off of the treated field into the pond. It  
21 almost seems as though return flow from irrigation, if  
22 you have a large irrigation event and you're moving a  
23 lot of water through the field, you might be adding  
24 more organic matter or more sediment than you would  
25 just from a series of runoff events and I was thinking

1 that that might be another issue that you could address  
2 right now without having to wait to develop more  
3 complicated models, and those are my comments.

4 **DR. HEERINGA:** Thank you, Dr. Abbott.  
5 Dr. DeLorme.

6 **DR. DELORME:** I'll try and keep it short  
7 and sweet. With respect to the first question the  
8 extent to which the Agency is identifying and  
9 characterizing unique or problematic issues, I think  
10 you guys have done a pretty good job. You've identified  
11 I would say probably ninety-five percent of the issues.  
12 There are a couple of things, however, that I didn't  
13 see there.

14 One is the issue of bound residues and  
15 the implication for determination of persistence of  
16 bioavailability. We do have a NAFTA project with you  
17 guys on that one. I think it is a consideration in  
18 this case. We do have to consider. I'm not quite sure  
19 how we're going to do it but we do have to look at that  
20 issue and there's probably science out there that can  
21 help us with respect to Superfund sites or other things  
22 but it is something that we need to consider.

23 The shift in risk. There is a shift in  
24 the risk, there's a shift in the risk spatially, okay,  
25 from maybe a field level to a far field. And

1 temporally, I mean there is risk obviously at the time  
2 of application but with these persistent chemicals and  
3 bioaccumulative nature especially when they're subject  
4 to LRT, I think we have to take a look and say what's  
5 the risk in twenty years.

6           We were sitting around the other night  
7 and we all said we would hate to be sitting there ten  
8 years from now and saying oh geez there's chemical  
9 four, and on the front page of The Washington Post. How  
10 did we get it wrong again? You know, and that's not  
11 what we want to do, you know, so I think we need to  
12 make sure that our assessments are good enough or our  
13 characterizations are good so that the risk management  
14 decision is good.

15           And in these cases, you know, the risk  
16 is shifting from being at the time of application to  
17 being later on, although it does exist at the time of  
18 application too, so in your model frameworks and  
19 whatnot or in your conceptual models that needs to be  
20 taken into consideration. I think it's there, but it  
21 wasn't explicitly stated.

22           And again, that leads to the next one  
23 which is the aerial scale of use is an important factor  
24 to be considered. We are obviously here using these  
25 kinds of chemicals on cotton or on corn or on wheat,

1 you know, on big crops like that there are  
2 implications.

3 If you're using it on smaller, for  
4 registered over smaller areas, well, you'll, you're  
5 going to have a different outcome, okay, but it does  
6 play into it, you know, and I think if we look at the  
7 chemicals that we had problems with in the past, part  
8 of the issue has been how much they're used.

9 The other thing I'd like to point out  
10 and it's not necessarily with the assessment but in  
11 risk management, and it's too bad Steve's not here but  
12 there's also a temporal separation between the benefit  
13 and the risk because of the persistent and  
14 bioaccumulative nature of these things. The benefit is  
15 going to be accrued at the time of application or  
16 shortly thereafter in terms of protecting crops or  
17 whatnot.

18 But the risks, although they occur at  
19 the time of application, they also are going to occur  
20 in the future. I think you have to be careful about,  
21 you know, making sure that that is characterized so  
22 that the risk managers understand that. And that's all  
23 I had to say on question one.

24 With respect to the need to incorporate  
25 refinements in the tools and methods, my interpretation

1 of this question is the need to incorporate new tools  
2 and refinements from where you are now with your sort  
3 of standard risk assessment.

4 I don't think we'd be sitting here if we  
5 all didn't think that we needed to do that, but I think  
6 the short answer to that is yes, definitely to the  
7 extent of refinement differs depending on the  
8 particular issue to be addressed but I think, I have a  
9 minor in evolution, I think what we see here is a case  
10 of punctuated equilibrium, it's a real leap forward.

11 For those of us who understand what a  
12 standard pesticide risk assessment has been for the  
13 last ten or fifteen years, you know, in, in the past  
14 five years with the addition of probabilistic now with  
15 the potential addition of additional methods for  
16 considering PBT chemicals, we're really looking at a,  
17 quite a step forward in our thinking in how we do  
18 these. So, you know, my only other comment there is you  
19 know, the refinements proposed should be based on  
20 science to the extent possible.

21 You know, we do science based risk  
22 assessment, that's what our job is. In some cases you  
23 know, we may not be able to use the best science, you  
24 know, because of the pressures we're under with respect  
25 to time and resources, but I think to the extent

1 possible what I've seen is based on science and you're  
2 to be commended.

3 **DR. HEERINGA:** Thank you, Dr. DeLorme.  
4 Dr. Oris?

5 **DR. ORIS:** Thank you. I'd like to start  
6 off by saying I think you did a very nice job of  
7 summarizing most of the scientific aspects of the  
8 issues here.

9 With regard to the things that Peter was  
10 just talking about, and he and I did talk about this a  
11 little bit at one of the breaks, there is a social  
12 aspect here that I think that you need to be explicitly  
13 aware of and deal with and that's that because the risk  
14 and the benefit are so separated in time and space and  
15 that if one thing we've seen especially in the last few  
16 weeks is that humans are really, really good at  
17 accepting instant gratification and at the risk of  
18 delayed impact.

19 That there's a social dimension here  
20 that you need to be very careful about and history  
21 repeats itself. We're looking at chemicals now that we  
22 weren't able to deal with in the past and that weren't  
23 being used that extensively when we developed the risk  
24 assessment method, so we're back where we started  
25 again.

1                   And so these kinds of chemicals  
2 personally scare me so I think that socially there's  
3 some things that need to be dealt with. As far as the  
4 second part, yeah, obviously there's refinements that  
5 need to be made. For a few examples, chronic toxicity  
6 is still an issue in my mind, but I think with  
7 refinements we can deal with that.

8                   Critters are not going to be dropping  
9 dead, so you're not going to know when you have an  
10 immediate problem so that they're going to have, you're  
11 going to have feminization, you're going to have  
12 changes in sex ratios, you're going to have decreased  
13 reproduction, you're going to have changes in behavior,  
14 how do you deal with these subtle effects with the  
15 effects of other multiple stressors or longer term  
16 change? So climate change and changing temperatures  
17 over time and how that might affect, so there's some  
18 evolutionary aspects that are of concern and need to be  
19 at least considered in these kinds of things.

20                   We need more clear links between aquatic  
21 and terrestrial systems, than there's some presence,  
22 but I think we need to do a better job of doing that  
23 and we need, because of that we need to explore  
24 additional receptors, I think in the risk assessment.  
25 So for example, birds, spiders, aquatic insects that



1 emerge, amphibians, anadromous fish.

2           These are things and benthos and epi  
3 benthic in organisms that move around and deal with  
4 things that adsorb to colloidal material. These are  
5 things that I don't think we do, we're dealing with now  
6 and you typically don't need to deal with the impacts  
7 of ocean going fish accumulating persistent chemicals  
8 from a pesticide long range transport and then bringing  
9 it back into another place continentally in a fresh  
10 water system.

11           So those are things that you're going to  
12 have to deal with and so the receptors that you're  
13 looking at I think are going to have to be expanded  
14 depending on the type of risk assessment you're doing.

15           We need, and I'll beat on this again, we  
16 need to address multi-compartment issues so, in larger  
17 organisms where these things may partition, those,  
18 these, we can't go with a simple single compartment  
19 organism and we also need to address some of the  
20 temporal issues, how long it takes for these things to  
21 accumulate and move from place to place and get around.

22           So those are sort of my summary comments  
23 on question eight. There's a lot of overlap in my mind  
24 between or among eight, nine and ten and so I'll come  
25 back to some of these tomorrow when we get to those.



1                   **DR. HEERINGA:**       Thank you, Dr. Oris. You  
2 cite some social aspect of this as well. Other  
3 comments from members of the panel on this particular,  
4 yes, Dr. Norstrom?

5                   **DR. NORSTROM:**       Going back to thinking  
6 outside the box again, I think it's important we talked  
7 about metabolism and solubility being important for  
8 bioaccumulation but we should also be considering  
9 metabolites I think.

10                               It's not just a question of whether  
11 these things partition or whatever, it's a question of  
12 whether some of the metabolites might also be  
13 persistent and that may not be something to do with its  
14 lack of phobicity or its hydrophobicity either.

15                               So some of the examples that I gave  
16 earlier are ones that I think need to be considered and  
17 we need to take a very exhaustive kind of view of what,  
18 how will this thing break down if you have the  
19 metabolites identified, then look at them and say well,  
20 they possibly may also be as or perhaps more  
21 persistent. Sometimes that happens, than, than the  
22 starting compound.

23                               Just looking at this Parabola model, for  
24 example, I can see that thing splitting off to produce  
25 something that looks very much like thyroid hormone.

1 If I looked at that myself I would say I wonder if this  
2 thing is acting like a, if that metabolite is present  
3 or some version of it, it could possibly be bound to  
4 TTR.

5 If you start looking at it in fat you're  
6 not going to find it so you wouldn't even know it was  
7 there and those kinds of surprises are around all the  
8 time so I think you really have to be very broad  
9 looking at each of these chemicals in terms of not just  
10 looking at it as a partitioning phenomenon in the  
11 animal.

12 **DR. HEERINGA:** Next, Dr. Meador.

13 **DR. MEADOR:** I just wanted to add to  
14 what Dr. Oris said. An example, long range transport,  
15 actually with some on it, say you go out into the open  
16 ocean and 90...oh, at least 99 percent of the PCBs that  
17 accumulate are from the ocean, you come back in some of  
18 our most pristine water sheds are actually contaminated  
19 by PCBs as they die and respond to a huge biomass.

20 **DR. HEERINGA:** Let me ask one question  
21 of my own interest. I know from as a liaison to the  
22 Science Advisory Board that the Office of Research and  
23 Development is looking into nanotechnology and its use.  
24 In OPP and in the Environmental Fate and Effects  
25 Division, are you thinking in terms of nano particles

1 and how they might be used in pesticides or are you  
2 seeing... maybe it's, I don't need to ask that question  
3 but is it something that's clearly on your mind and  
4 that you're thinking about at this point?

5 **DR. TORTON:** Dr. Heeringa, I'm Bill  
6 Torton with the Office of Pesticide Programs, and I  
7 might be able to provide a little bit of background and  
8 answer that question.

9 We have within the Office of Pesticide  
10 Programs formed a team to study the field of  
11 nanotechnology and to anticipate the scientific and  
12 regulatory issues that will confront us when we receive  
13 some applications for registrations of products for  
14 uses, pesticides that are based on nanotechnology or  
15 that incorporate nano materials.

16 So far we have not received any  
17 applications, although I will note as some of you may  
18 already be aware, that there are in the marketplace  
19 products that claim to use nanotechnology that make  
20 pesticidal claims. There are gym socks that supposedly  
21 have nano particles in them that keep the socks and  
22 maybe even your feet from smelling bad and there are  
23 air fresheners and other products that supposedly  
24 operate with a pesticidal mode of efficacy.

25 We are working with the nanotechnology

1 industry to remind them of their responsibilities to  
2 get registrations if they are in fact selling products  
3 with pesticidal claims regardless of whether or not  
4 they make, whether they actually use nanotechnology.  
5 As I said we haven't received any such applications,  
6 but we've been working with our colleagues in the  
7 Office of Pollution Prevention and Toxics where they  
8 have seen a number of products in nanotechnology.

9           And we're working with our sister  
10 agencies, the FDA and other parts of HHS and I just  
11 found out that Dr. Abbott is heading up a similar  
12 program or part of a similar program at USDA and was  
13 happy to make that connection.

14           The team of people includes folks from  
15 the Environmental Fate and Effects Division, from our  
16 Health Effects Division, from our Biological and  
17 Economic Analysis Division to help us with exposure and  
18 use patterns, as well as lawyers and folks like me who  
19 do policy work so we think we're trying to get ahead of  
20 it, but the more we work on it, the more we discover,  
21 to use a phrase that just happened earlier, that there  
22 are a lot of unknown unknowns.

23           **DR. HEERINGA:**       As I understand and you  
24 correct me, too, that in the registration process now  
25 the guidelines have been clarified so that if carriers

1 or other secondary components of the compound including  
2 nano particles, those are reported to you by size  
3 categories?

4 **DR. TORTON:** We are hoping to clarify  
5 that. We expect that with our current version of our  
6 regulations and guidelines that information will be  
7 part of the description of the statement of the  
8 formula, the products that applicants provide to us  
9 with their products but we're, as I say, working to  
10 clarify that as well.

11 **DR. HEERINGA:** Very good, thank you Dr.  
12 Torton. Other comments on this particular question or  
13 is everybody ready to take a break for the evening?  
14 I'd like to thank everybody today, oh, first of all  
15 before I get ahead of myself, I'll turn to Dr. Brady,  
16 Dr. Parker, Andrea, any questions of clarification on  
17 this last, on question eight?

18 **DR. BRADY:** I just want to, this is to  
19 go back to Dr. Abbott's discussion about looking at  
20 pesticide residues in terrestrial ecosystems.

21 We included an analysis of that  
22 accumulation in the White paper as an illustration to  
23 show what the capabilities of PRZM are, that we could  
24 get that information from PRZM.

25 We normally don't use that information

1 in our terrestrial risk assessments and that's, we feel  
2 that there's some useful information in there when we,  
3 we can model accumulation in the soil of the  
4 environment, we might be able to take that further and  
5 look at that in our terrestrial risk assessment.

6 That's...

7 **DR. HEERINGA:** Well, if there are no  
8 other comments this afternoon, I think with question  
9 eight there will be ample opportunity in the context of  
10 questions nine and ten to introduce your thoughts  
11 tomorrow, and I would like to I think adjourn for today  
12 and give everybody a chance for a break, it's been a  
13 very productive session.

14 I always learn something here, I should  
15 be learning something, I don't know much to start with,  
16 and I appreciate everything that everyone has  
17 contributed today.

18 And so let's call it a day and we will  
19 reconvene tomorrow morning at 8:30 to pick up charge  
20 questions nine and ten and my intent is that we will  
21 cover these within the three hours that the agenda has  
22 provided us.

23 So if we could sort of set that in our  
24 mind and I think that's ample time for these two  
25 issues, an hour and a half or a little over an hour and

1 twenty minutes each with a break should be able to do  
2 that, so Myrta, do you have any comments? Nothing from  
3 the DFO so we'll say good afternoon, good evening to  
4 everybody and see you tomorrow morning at 8:30.

5 **(WHEREUPON,** the **MEETING** concluded at 4:12 p.m.)  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25

CAPTION

The foregoing matter was taken on the date, and at the time and place set out on the Title page hereof.

It was requested that the matter be taken by the reporter and that the same be reduced to typewritten form.

Further, as relates to depositions, it was agreed by and between counsel and the parties that the reading and signing of the transcript, be and the same is hereby waived.

1 CERTIFICATE OF REPORTER  
2 COMMONWEALTH OF VIRGINIA  
3 AT LARGE:  
4 I do hereby certify that the witness in the foregoing  
5 transcript was taken on the date, and at the time and  
6 place set out on the Title page hereof by me after  
7 first being duly sworn to testify the truth, the whole  
8 truth, and nothing but the truth; and that the said  
9 matter was recorded stenographically and mechanically  
10 by me and then reduced to typewritten form under my  
11 direction, and constitutes a true record of the  
12 transcript as taken, all to the best of my skill and  
13 ability.  
14 I further certify that the inspection, reading and  
15 signing of said deposition were waived by counsel for  
16 the respective parties and by the witness.  
17 I certify that I am not a relative or employee of  
18 either counsel, and that I am in no way interested  
19 financially, directly or indirectly, in this action.  
20  
21  
22  
23  
24 MARK REIF, COURT REPORTER / NOTARY  
25 SUBMITTED ON OCTOBER 30, 2008

0	<b>25</b> 142:22 160:12	<b>7.5</b> 54:17
<b>0</b> 35:22	<b>29</b> 101:22	<b>7.8</b> 102:19
<b>0.1</b> 27:10 28:3,9	<b>2-line</b> 17:8	
<b>0.3</b> 113:10		8
<b>0.4</b> 27:13	3	<b>8</b> 74:5 79:2 80:19
<b>0.5</b> 27:13 34:16	<b>3</b> 3:10 4:20,21	137:17
<b>04</b> 73:6	5:5,15 29:7,21	<b>8:30</b> 216:6 243:19
	30:15,24 46:20	244:4
	51:9 74:5	<b>800</b> 76:9
1	98:5,19 106:6,17	<b>86</b> 171:16
<b>1</b> 19:11	109:17 128:2	
27:10,13,20,21	<b>3.5</b> 53:24 94:22,24	9
28:9 29:6,9	<b>3.8</b> 100:22	<b>9</b> 41:18 45:10 77:14
35:4,13,22 48:15	<b>3:00</b> 89:8	79:2
50:9 57:13,14,18	<b>3:30</b> 215:15	<b>90...oh</b> 239:16
60:16 68:13 69:3	<b>30</b> 2:3 57:13	<b>90th</b> 214:7
75:3 76:4 82:13	<b>3000</b> 189:16	<b>99</b> 239:16
85:4 88:23 93:12		<b>99.99</b> 17:9
98:15 99:14 100:17	4	
105:20 127:15	<b>4</b> 18:15 30:14,16	A
<b>1.5</b> 77:13	46:19,23,25 48:6	<b>a...a</b> 5:18 7:10
<b>1:10</b> 139:8	50:12 51:10	23:5,9 45:20 53:23
<b>10</b> 88:17 102:19	52:19 74:5 82:8	56:8 58:12 59:1
<b>100</b> 6:5	88:13,23 100:13	62:14 71:4,5 78:20
<b>10-year</b> 60:16	106:21 128:2	79:10 86:6 92:20
<b>11:00</b> 88:18	<b>4.5</b> 53:21	93:12 94:19 98:4
<b>120-day</b> 102:20	<b>4:12</b> 244:5	109:1,15,17
<b>139</b> 68:11		118:3 119:19,22
<b>14</b> 14:5,6	5	139:6
<b>1960s</b> 182:16	<b>5</b> 38:9 51:13 73:1,2	<b>a...a...putting</b>
<b>1970s</b> 203:3	88:14,24	33:24
<b>1990s</b> 203:3	89:10,12 95:3	<b>a...a...quite</b> 91:14
<b>1993</b> 156:12	133:1	<b>a...almost</b> 48:16
<b>1-D</b> 44:15	<b>5.18</b> 68:10	<b>a...an</b> 4:24 22:1
	<b>5.7</b> 102:19	39:25 85:18 135:4
2	<b>50</b> 13:6 58:2	<b>a...and</b> 120:7
<b>2</b> 8:20 18:13	146:1 160:12	<b>a...another</b> 39:5
19:13 29:6,11	<b>50s</b> 148:9 149:23	<b>a...are</b> 14:24
48:19 50:10,11		<b>a...as</b> 67:5
<b>2:00</b> 89:8	6	<b>a...data</b> 120:10
<b>20</b> 19:12	<b>6</b> 61:24 75:10 80:13	<b>a...for</b> 36:17 82:2
<b>2000-2001</b> 193:22	88:14 102:5 114:13	<b>a...from</b> 74:11
<b>2003</b> 101:21	139:20 140:6,8	<b>a...I'm</b> 14:23
<b>2004</b> 160:7	<b>60</b> 141:18	<b>a...in</b> 119:19
<b>2005</b> 189:12		<b>a...is</b> 59:24
<b>2008</b> 2:3 136:11	7	<b>a...it's</b> 22:20
<b>22</b> 101:22	<b>7</b> 54:16 74:5 102:5	

<b>a...just</b> 81:24	<b>abundance</b> 54:13	<b>acquire</b> 160:22
<b>a...like</b> 95:5	<b>abusagens</b> 158:17	<b>ACR</b> 159:17
<b>a...of</b> 130:19	<b>accept</b> 56:22 122:7	<b>acre</b> 124:25
<b>a...on</b> 117:24	<b>acceptable</b> 152:3	<b>acronym</b> 183:2
<b>a...probably</b> 46:12	<b>accepting</b> 235:17	<b>acronyms</b> 141:23
<b>a...the</b> 123:8	<b>acceptor</b> 197:9	142:1
<b>a...there's</b> 8:11	<b>accommodate</b> 199:5	<b>across</b> 55:18 181:21
26:9 36:18	<b>according</b> 169:25	206:17 218:25
<b>a...to</b> 136:6	191:12 195:13	<b>act</b> 144:18 145:3
<b>a...with</b> 22:8	200:15	204:17
<b>Abbott</b> 208:18 217:9	<b>account</b> 31:14 96:19	<b>acting</b> 239:2
223:14,15 229:18	117:17 166:22	<b>action</b>
231:4 241:11	169:7 197:5 222:19	144:5,7,8,9,12,13,
<b>Abbott's</b> 242:19	<b>accounted</b> 21:4	14,24 149:25
<b>ability</b> 225:24	<b>accounting</b> 22:21	153:16 155:4,9
<b>able</b> 46:4 89:1	<b>accounts</b> 21:5 143:1	156:6,8 166:4,8,13
103:22 112:21,24	<b>accrued</b> 233:15	167:1,5,16,20,21
117:15 119:19	<b>accumulate</b> 100:15	174:20 175:3
121:2 127:12 155:6	113:20 229:10,15	176:7,9
163:23 173:21	237:21 239:17	<b>actions</b> 156:13
174:14 194:2	<b>accumulated</b> 106:11	<b>activated</b> 155:21
196:10 203:18	<b>accumulates</b> 39:16	<b>active</b> 103:8 133:20
225:7 227:10	71:16 100:20	155:19 186:1
234:23 235:22	229:12	<b>actively</b> 226:16
240:7 243:4 244:1	<b>accumulating</b> 100:24	<b>activities</b> 78:9
<b>about...about</b>	117:9,25 237:7	<b>activity</b> 112:15
115:25	<b>accumulation</b>	134:4 170:14
<b>about...before</b>	48:23 51:6 53:19	<b>actual</b> 3:23 14:19
30:18	64:10 76:17	71:1 88:4 111:25
<b>about...that's</b> 17:7	91:14 98:9	138:12 140:17
<b>about...we're</b> 139:1	111:25 113:19	144:19 170:6 172:8
<b>about...you</b> 45:14	114:17 123:5 127:6	182:12 202:6
<b>absence</b> 175:1	166:17 227:13,25	203:11,21
<b>absolute</b> 189:25	228:5,23 229:2	<b>actually</b> 3:25 11:22
190:2,6 193:7	230:1 242:22 243:3	16:5,14 23:2
194:7,25 195:12	<b>accurate</b> 68:5	26:4 32:1 34:24
201:21	191:11 197:11	35:16 36:3,25 39:9
<b>absolutely</b> 15:19	199:17 202:10	45:17 52:18 64:8
28:20 151:6	<b>acetlycholinesteras</b>	70:13,15,16
<b>absorbed</b> 16:5,8	<b>e</b> 155:22	71:9,20 74:3
75:4	<b>acetylcholinesteras</b>	75:4 77:12 78:10
<b>absorption</b> 13:16	<b>e</b> 144:11	93:10,20 105:8
15:1,5 28:15	<b>achieve</b> 98:1	110:24 113:3
29:5 74:11 75:1	<b>acid</b> 211:10	120:22 128:4
<b>absorption...why</b>	<b>acids</b> 132:5	131:22 132:17
13:1	<b>acknowledging</b> 48:9	133:21 147:14,21
		148:1,11

149:18,21,23  
 150:11,17,23  
 151:13 153:9,10,17  
 155:17 157:23  
 158:2 159:2 165:20  
 167:3,9 168:13  
 169:24 170:21  
 171:2,18  
 172:8,16,25 173:19  
 176:2,4 187:12  
 189:10,15,19  
 201:23 203:4,8  
 204:1 205:1,15  
 207:22 208:18  
 209:4 210:12 211:5  
 226:12 229:1  
 239:15,18 241:4  
**acute** 60:15 89:18  
 159:9,10,12,13,15,  
 25 163:14,16  
 165:24 169:21  
 170:2 174:21,24  
 175:9,11,15,19,24  
**adapt** 23:1 62:23  
 219:10  
**adaptable** 136:18  
**adapted** 136:6  
**add** 14:10,15  
 16:15 19:10  
 26:12 52:5 65:24  
 66:4 70:3,9 72:1  
 87:9,21 92:8 99:24  
 104:21 144:25  
 145:4 161:7 163:21  
 171:9 204:13  
 239:13  
**added** 19:19  
**adding** 69:15 85:8  
 230:23  
**addition** 22:9 132:9  
 216:19 234:14,15  
**additional** 5:1,14  
 7:17 55:24 59:17  
 77:4 83:7,8 86:3  
 115:23,24 133:1  
 136:2 139:24 140:2  
 145:14 158:10  
 172:1 174:15  
 179:11 180:13  
 191:25 204:11  
 234:15 236:24  
**additionally** 39:4  
 58:23  
**additions** 5:9  
**additive** 144:22  
 145:1  
**additivity** 166:16  
**address** 48:23  
 49:4,11 57:15 67:1  
 70:25 90:24 91:1  
 99:20 113:18,19  
 117:6 118:10  
 140:18 141:19  
 146:19 162:22  
 213:25 216:22  
 224:13 227:6 231:1  
 237:16,19  
**addressed** 49:8  
 59:5,13 99:17  
 136:22 164:17  
 171:3 179:13 234:8  
**addresses** 64:20  
**addressing** 65:14  
 71:7 87:1 117:3  
 141:1  
**adds** 57:20 82:5  
**adequate** 39:25 40:2  
 50:6 122:16 123:21  
 124:12  
**adjacent** 228:20  
**adjourn** 243:11  
**adjust** 45:8  
**adjusted** 127:10  
 151:11  
**adsorb** 237:4  
**adsorption** 16:17  
 31:9 36:6  
**adsorption/  
 desorption** 12:15  
**adult** 59:22  
**advancement** 44:23  
 205:8 212:21  
**advantage** 142:25  
 143:14  
**advantageous** 143:21  
**adverse** 158:15  
 159:3  
**advice** 85:14  
**advisory**  
 2:1,18,22 139:14  
 239:22  
**advocating** 62:16  
**aerial** 94:16  
 125:1 210:8,9  
 224:24 232:23  
**A-E-R-I-A-L** 210:8  
**aerobic** 214:16  
**aerosol** 196:25  
**affect** 19:23 101:17  
 236:17  
**affected** 79:8 159:1  
 196:25 199:14  
**affects** 202:21  
**affinity** 187:18  
**affinity** 188:11  
**afield** 84:2  
 129:23 136:8  
 181:19 183:11  
**Africa** 182:14  
**afternoon** 2:16 89:8  
 138:16,23 139:4,12  
 243:8 244:3  
**Ag** 208:6 214:1  
 228:19 230:14  
**against** 166:19  
 198:2  
**agencies** 224:25  
 241:10  
**agency** 5:21 47:9  
 89:13,19,25  
 140:14,19,22  
 208:21  
 216:14,19,25  
 217:3,19 218:23  
 219:15 220:19  
 223:18 231:8  
**Agency's** 48:2 50:23  
 167:18  
**agenda** 89:6  
 138:22 139:2,3  
 200:4 215:11

243:21	209:20,21,23,24	143:4 190:1 237:24
<b>aggregate</b> 75:2	210:15,23 225:14	<b>amount</b> 16:1,4,6
<b>aggregation</b>	240:23	17:16,17 19:15
212:13,18,20	<b>al</b> 31:23 58:14 80:6	21:24 52:16 66:4
<b>AGNIPs</b> 226:6	136:10 186:12	71:16 93:19,21
<b>ago</b> 32:3 78:7 163:7	189:12	118:1 122:7
166:6 181:6 224:17	<b>al...although</b> 62:18	151:4 190:15
<b>agreed</b> 194:6,10	<b>Alberta</b> 210:16	201:21
<b>agreement</b> 194:24,25	<b>alert</b> 208:21 224:11	<b>amphibians</b> 49:22
195:10 203:10	<b>alga-corto-benzo-</b>	59:21,22 237:1
<b>agricultural</b> 32:9	<b>dioxin</b> 169:3	<b>ample</b> 216:10
114:3 123:12	<b>algae</b> 70:13,18	243:9,24
130:10 182:2 225:1	<b>algal</b> 59:12	<b>anabacteria</b> 80:9
227:9,12,21	<b>algebraic</b> 42:6	<b>anadromous</b> 237:1
228:3,9,11	<b>algorithms</b> 122:13	<b>analogous</b> 119:23
<b>Agriculture</b> 224:16	<b>aligned</b> 173:20	<b>analysis</b> 24:5
<b>agro</b> 6:14 10:22	<b>alimetric</b> 113:10	98:5 104:15
13:13 18:25	<b>allow</b> 14:12 23:2	140:2 193:3
22:17 31:1 67:9	45:13,17 56:21	209:13,16 214:23
76:2 130:8	82:6 167:10,11	241:17 242:21
<b>AGRO/PRZM/QUASI</b>	195:12 214:23	<b>analytical</b> 205:18
73:5	<b>allowed</b> 19:10 195:1	<b>anchoring</b> 20:1
<b>ahead</b> 3:6 8:20	<b>allows</b> 33:15	<b>ancillary</b> 171:18
33:16 50:14	82:15 128:13	<b>ancio</b> 114:9
139:1 141:10 178:6	<b>alluded</b> 213:25	<b>and...and</b> 6:12
220:16 241:19	<b>alluding</b> 13:9,12	13:17 16:16
242:15	<b>alpine</b> 110:22	26:23 29:16
<b>aid</b> 135:24	<b>already</b> 4:1 46:7	30:17 31:4 32:11
<b>aims</b> 5:9	65:25 75:16	33:13 36:15
<b>air</b> 45:25 54:5	81:25 82:1,17	48:12 49:14
91:13,15,18	116:14 136:1	51:11,19 52:5,17
92:3,18	165:13 167:22	53:17 54:2,4
96:4,8,13,17	189:11 197:25	56:4,15 57:15,17
97:8,12 106:1,9	198:17 213:24	58:11 59:20,23
107:1 116:21,23	228:7,15 240:18	60:13 61:7,8,16
126:2,5 148:14	<b>alternative</b> 48:22	62:16 63:2 64:1,25
180:24 181:13	72:4	65:3,12 66:24
183:3,7,13	<b>alternatives</b> 47:23	72:6,22 76:5,24
185:2,3,5,9,17,23	<b>am</b> 2:6 43:8	77:9 78:6 79:7
186:15,16	<b>ambient</b> 142:5,19	80:22
187:2,4,14,17	151:9 183:3	86:21,23,25
188:10,19 191:15	<b>amenable</b> 152:23	87:19 90:12,19
192:13,17,19	153:6 160:20	91:8,11 92:16,23
193:20,24 194:2	<b>America</b> 183:4	93:5,16 95:23 99:3
197:20 202:6,13	<b>American</b> 183:8	105:4 109:3
203:1,18 206:25	<b>among</b> 112:12	111:2 115:2,20
207:13		116:17 117:20,21

118:16 119:7	<b>anyone</b> 34:12	163:24
125:22 130:9 132:8	<b>anyone's</b> 53:4	<b>appreciate</b> 4:14
133:15 134:10	<b>anything</b> 3:25 4:3	43:4,5 84:21 85:15
<b>And...and...I</b> 85:17	26:12 29:17,23	179:15 243:16
<b>and...but</b> 33:11	78:22 94:22,24	<b>approach</b> 6:19
<b>and...but...but</b>	99:23 111:11	14:2 22:18 23:3
11:18	135:22 160:19	47:14,16 48:2
<b>and...which</b> 11:23	166:23 170:15	50:2,24 51:22,25
<b>Anderson</b> 133:13	171:9 176:11 181:8	61:4,16 63:8,14
136:21,24 175:10	<b>anyway</b> 34:4,6	66:24 72:24
<b>Andrea</b> 58:14 242:16	73:9 76:11 97:2	73:18,22 78:17
<b>angio-hepatic</b> 132:2	116:6 122:17	82:2,10,11 83:2
<b>animal</b> 59:20	164:19 177:12	84:10 93:5 98:2
71:16 74:24	216:7 220:18	110:12 117:25
90:21 112:24 126:9	<b>anyways</b> 217:17	121:15 123:3
130:15 143:10	<b>anywhere</b> 103:25	127:14,15
155:16 157:3,6	110:10 210:11	140:20,25
161:10 177:1	<b>apart</b> 14:5	141:3,17,21
239:11	<b>apologize</b> 141:22	142:3,9 147:5,9
<b>animals</b> 58:19 76:15	<b>apparatus</b> 45:4	148:1,15
100:13 103:2,20	<b>apparently</b> 31:25	149:6,20 152:17
111:16 126:16	169:25	155:24 159:7
127:8 133:8 149:14	<b>appeared</b> 227:19	160:16,20,24 161:8
157:11,15 158:18	<b>applaud</b> 32:7,15	164:9 165:9
171:22	<b>applicability</b> 48:1	167:18,21 176:22
<b>animal's</b> 143:20	<b>applicable</b> 51:12	177:3 198:11,22
<b>answer</b> 13:22 15:8	104:2 115:6,7	214:3,11 222:18
43:25 48:15	116:6 119:2 211:11	<b>approaches</b> 48:22
61:17 104:13 108:1	<b>applicants</b> 242:8	50:25 60:19 71:8
121:17 152:17	<b>application</b>	75:13 83:14
164:6 198:19	14:10,15,20	87:18 98:23
206:1,2,9 208:16	31:22 38:16 57:6	117:4 213:4 216:20
219:6 221:12	110:21 122:19	<b>appropriate</b> 7:6
224:21 234:6 240:8	124:24 200:19	8:12,21 10:2
<b>answered</b> 33:2	219:19 232:2,16,18	20:2 25:5
<b>Antarctic</b> 182:25	233:15,19	69:4,25 93:7
<b>anticipate</b> 4:22	<b>applications</b> 14:4	106:15 121:4 141:2
240:11	116:25 128:4	191:9 215:9
<b>anticipated</b> 125:1	200:23 223:23	<b>appropriately</b>
<b>anticipatory</b> 209:10	224:5,14 240:13,17	159:18
<b>any...any</b> 32:15	241:5	<b>approximate</b> 42:14
<b>any...Khristina</b>	<b>applied</b> 22:8	45:24 99:2
136:22	26:10 91:15 99:7	<b>approximately</b> 80:17
<b>any...there's</b> 65:14	201:8,9,19	102:18
<b>anybody</b> 170:5	<b>applies</b> 19:1	<b>approximation</b>
<b>anybody's</b> 211:3	<b>apply</b> 64:9 68:17	35:5 99:4,6 113:1
<b>anymore</b> 209:19	150:8 151:18	<b>aquatic</b> 7:24

46:25 47:2 49:19 114:5 123:12 151:14  
 54:10 55:10,11 125:14 134:4 145:5 **assess** 89:20  
 59:10,23 60:7 163:13 173:10 148:2 184:24 186:8  
 65:15 85:9 86:19 200:1 210:1,2,10 198:20 199:24  
 89:24 97:25 109:11 212:6 213:12 223:9 217:4 224:4  
 110:11,18 111:9 228:6,16,19,25 **assessed** 198:23  
 116:11 118:6 229:6,19 230:2,12 212:8  
 119:3,6,24 134:8 **areas** 91:21 182:2 **assesses** 89:13  
 137:19 138:4 203:22 227:12 **assessing** 47:14  
 140:10,13 157:11 233:4 48:3,17 89:22  
 216:17 229:20 **aren't** 82:7 143:17,22 144:21  
 236:20,25 111:11 135:2 179:24 180:6  
**aquatic...or** 118:5 169:11 227:17 198:12 216:15  
**aquatic/terrestrial** **aren't...they're** 217:1 218:10  
 59:25 54:3 **assessment**  
**aquaticly** 86:22 **arguably** 199:21 2:11,24 5:18 46:14  
**aqueous** 22:4 47:5 **arial** 210:9 47:1,18,20,23 67:3  
 75:1 164:19 **Armitage-Gobas** 84:6,8 89:16  
**aquifers** 18:7 162:15 90:3 98:16  
**arbitrary** 30:13 **Army** 150:21,24 104:10,15,18  
 31:8 94:21 **Arno** 53:17 57:3 109:10,11  
**Archipelago** 184:6,8 58:25 60:4 73:5 110:9,10,17,18  
**arctic** 110:22 **aromatic** 149:9 119:20 121:25  
 136:12 181:20 171:15 122:3,6,9 123:22  
 182:25 183:12 124:3,9,16  
 184:1 **arrive** 108:14 126:21,24  
 186:2,4,6,10,18,23 **arrives** 215:14 127:2,12,21 135:24  
 190:13 193:22 **arrows** 187:7 139:15 142:3  
 194:16 195:16 **art** 94:2 95:9 160:16 172:19  
 197:16,18 199:1 115:18 120:11 174:16 179:23  
 205:20 **article** 136:10 184:14 207:23  
**are...are** 21:10 **articles** 136:10 208:24 216:21  
 22:20 26:22 **artificially** 221:16 224:19  
 31:13 49:25 22:10,18 227:2 229:20,21,22  
 55:14 56:1 60:1 **as...as** 49:12 57:19 233:10 234:3,12,22  
 73:21 90:22 62:7 64:10 235:24 236:24  
 98:20 108:20 118:6 74:12,21 83:5 237:14 243:5  
 130:1 87:25 110:10 **assessments** 5:13  
**are...are...we** **Asia** 182:8 33:13 47:9  
 108:14 **aspect** 11:25 55:9 127:22 135:23  
**are...have** 16:12 59:5 119:4 124:2 136:18 153:4  
**are...there** 33:3 135:16 162:24 207:6,25 216:17  
**are...whether** 81:16 166:2 207:4 235:12 220:20 227:3  
**are...which** 11:10 238:2 232:12 243:1  
**area** 13:3 17:2 50:4 **aspects** 58:21 75:19 **assigned** 5:3 168:7  
 71:18 89:16 162:24 174:19 **associate** 4:25  
 92:22 111:8 235:7 236:18 65:23 92:10  
**assay** 150:5,6 161:4 204:9 206:12

215:23 223:14	33:21,25 34:2	128:2 169:6 222:17
<b>associated</b>	37:14,16	<b>balance...well</b> 45:9
2:10,23 47:20 53:8	<b>available</b> 2:14,15	<b>balances</b> 223:7
139:15 217:1,23	6:2 36:10,11	<b>ball</b> 198:4
227:20	45:13,16 46:2	<b>Baltic</b> 169:7
<b>associates</b> 50:20	47:17 54:24 84:7	<b>bang</b> 219:12
<b>assume</b> 10:6 12:6	108:4,21 122:16	<b>bank</b> 226:9,10
18:25 30:5,7	127:20 143:9 172:7	<b>barium</b> 18:22
38:1 40:1 65:5	180:8 197:15 212:6	<b>barrier</b> 75:17
68:24 69:18	<b>average</b> 55:1 159:22	<b>base</b> 13:13 20:24
80:21 105:20	191:17	59:7 150:22,24
122:12,16 156:4	<b>averaged</b> 60:15	167:13 225:9
170:1 199:13	<b>averaging</b>	<b>based</b> 6:2,11,17 7:6
227:16	107:8,9,11	23:23 37:14
<b>assumed</b> 65:4 101:25	<b>avian</b> 87:6	41:1,2,4 60:16
<b>assuming</b> 76:3	133:17,23 173:22	71:14,21 75:13
78:3 165:24	178:20	82:17 86:22 109:21
166:3 228:8	<b>avocados</b> 207:10	122:20 141:19
<b>assumption</b> 25:9	<b>aware</b> 31:21 32:5	143:22 145:11
63:13 69:23,25	82:19 103:11	150:12 152:22
101:16 118:18	132:20 162:21	155:8 166:14 177:3
123:6,8 160:24	166:22,24 235:13	185:1,8,13,14
<b>assumptions</b> 10:20	240:18	234:19,21 235:1
52:11	<b>away</b> 11:15 30:13	240:14
66:14,16,20,22	44:6 83:13 84:4	<b>baseline</b> 155:10
68:8 159:6 166:16	91:22 111:12	156:14 157:3
<b>ASTM</b> 27:12	147:19 148:2	176:4,8
<b>at...and</b> 126:17	168:15 209:12	<b>bases</b> 150:21
<b>at...at</b> 33:9	<b>awfully</b> 102:5	<b>basic</b> 62:21 98:8,16
74:21 99:11 120:4	118:19	150:20
<b>at...let's</b> 139:7	<b>axis</b> 10:12	<b>basically</b> 24:23
<b>at...you</b> 83:1	41:11,14,15	96:1 101:7
<b>Atkinson</b> 199:21	187:3,4	111:2,10,17
<b>atmosphere</b> 187:22		113:9 142:3
188:8 212:1	B	143:1 145:3
<b>atmospheric</b> 94:23	<b>B,C</b> 190:5	146:13,17 147:1
113:20 114:18	<b>background</b> 58:18	148:24 151:16
115:15 117:3	240:7	152:2,8,18
118:16 120:22,25	<b>backwards</b> 65:18	155:10,18 159:14
183:22 184:8 195:3	146:22 147:11	160:7 209:23
197:22 198:14	<b>bad</b> 176:5 187:11	<b>basis</b> 24:14 52:17
199:16 212:2,6,9	233:11 240:22	115:14 120:10
213:11	<b>BAF</b> 146:22	<b>Bay</b> 213:6
<b>attempt</b> 221:12	<b>balance</b> 9:15 45:9	<b>BCF</b> 47:23 48:17
<b>attention</b> 53:19	98:12,19	55:22 56:9,18
139:21 140:1 160:8	125:5,11,12	66:25 146:12 147:4
<b>automatically</b> 27:22	126:7,10 127:16	152:18

**BCFs** 47:4 51:4 235:14 96:18 128:18,21  
 56:15,22 147:7 **Bennett** 150:22 142:10 223:9  
**BCS** 67:19 **benthic** 31:2 **bile** 149:12 169:4  
**be...and** 63:7 33:19,23 34:1,3 171:18  
**be...that** 44:23 37:18 38:9 74:11 **biliary** 171:14  
 45:22 237:3 **Bill** 114:24 240:5  
**be...work** 72:25 **benthos** 57:25 237:2 **Bill...and** 108:12  
**bear** 67:18 81:2 **best** 37:19 54:25 **binding** 16:13 132:6  
 141:25 55:14 58:4 155:20  
**bears** 63:23 64:2 122:18 149:20 **binds** 132:15 155:21  
 134:21 152:13 154:6 **bio** 132:5  
**beast** 99:10 176:22 177:7 **bio...**  
**beat** 49:22 237:15 182:20 215:4 **bioconcentratable**  
**Beaufort** 184:4 234:23 110:7  
**beauty** 196:11 **bet** 208:2 **bio...if** 56:11  
**become** 16:5 17:17 **beta** 100:19 105:8 **bioaccumuation**  
 75:20 108:8 **Betat** 130:8 46:25  
**becomes** 54:16 74:14 **better** 6:22 13:24 **bioaccumulation**  
 106:10 144:20 15:7 23:8 25:16 47:2,7,11,15,19,21  
 183:21 195:4 213:2 45:24 58:10 ,24 48:3  
**becoming** 197:14 61:16,19 86:7 89:7 49:11,14  
**been...but** 12:21 90:15 127:23 51:13,19 53:2,16  
**been...I** 95:10 143:19,20 54:9 60:8  
**begin** 17:4 140:5 194:24,25 195:10 64:6,17,21  
 175:6 198:7 209:4 236:22 65:12,17  
**begins** 17:5 201:15 **better...at** 41:25 72:11,17 77:9 83:3  
**begs** 106:25 **between...** 89:20,22 90:1,5  
**behavior** 16:17 **transfer** 78:11 95:20 101:23  
 124:12 155:8 **beyond** 95:21,22 102:16 105:1  
 158:10 236:13 99:13 118:22 130:14 133:5,12  
**behaviors** 218:5 163:13 166:3 134:7  
**behind** 134:22 200:10,14 135:9,20,25  
**believe** 3:14 8:9,10 **Biddleman** 32:6 136:4,12  
 12:1 13:17 20:15 113:16 133:2 137:6,11 150:6  
 26:8 32:21 34:3 **Bidleman** 32:7 152:22 216:16  
 36:16 58:11,25 113:17 238:8  
 67:14 79:2 80:7 133:3,16,19,25 **bioaccumulative**  
 81:1 118:8 136:9 180:11,16,18 2:12,25  
 122:12 170:13 187:14 203:25 160:17,19 164:11  
 175:14 213:19 204:5 205:15 218:6 232:3 233:14  
 226:8,11 206:20 209:15 **bioassays** 146:19  
**bell** 79:13 102:22 210:6 211:5,16 **bioavailability**  
**Beluga** 63:22,24 214:12,21 215:22 55:17 72:11,16  
**bend** 35:17,22 **Bidleman's** 204:14 143:2,7 231:16  
 36:19,23,24 **bigger** 41:16 **bioavailable**  
**benefit** 233:12,14 103:2 158:18 25:10 65:2,5  
**biggest** 94:8 **bioavailbility...**

<b>bioavailability</b>	85:8 86:6,16,20	177:10 178:16
64:17	88:6 101:8	179:4 229:7,9
<b>bioconcentration</b>	102:24 112:13	<b>body's</b> 157:13
56:11	113:8 117:19	<b>boils</b> 142:16
<b>biochemical</b> 144:20	118:22 119:7	<b>bonding</b> 197:9
<b>bioconcentratable</b>	129:13 133:7,14	<b>book</b> 20:10 189:8
109:3	134:17,21 157:17	<b>borders</b> 130:9
<b>bioconcentrate</b>	171:4 236:25	<b>Boreal</b> 195:21
163:6	<b>bit</b> 23:2,17 27:20	<b>borrow</b> 135:23
<b>bioconcentration</b>	53:25 55:3 57:7,20	<b>borrowing</b> 49:5
47:3	61:24 62:10	<b>bottled</b> 7:6
55:4,5,14,16	65:11 67:18	<b>bottom</b> 31:12
56:3,7 68:4	69:13 73:16	107:9 207:16 219:7
69:5,13 93:13	75:20 76:5 79:10	<b>bound</b> 231:14 239:3
<b>bio-cumulative</b>	82:9 83:16,17	<b>boundaries</b> 44:21
141:19	94:12 97:1,13	<b>boundary</b> 202:13
<b>Biocumulative</b>	99:22 100:17 101:3	203:1
139:16	109:4 110:4 114:16	<b>bounds</b> 105:24
<b>bio-dilute</b> 59:15	120:23 127:13	<b>box</b> 42:4,13,14,15
<b>biodiversity</b> 130:9	130:22 138:7 139:8	44:3,14 45:10
<b>bioenergetic</b> 58:20	143:11 150:4,23	116:21 131:20
<b>bioenergetics</b> 63:1	151:14 153:11	169:10 191:8,18
<b>biological</b> 59:8	162:13 164:22	238:6
77:11 161:14	165:14 166:2	<b>boxes</b> 41:21
241:16	169:22 173:2	<b>Bradbury</b>
<b>biology</b> 59:20	175:11 207:15	130:20,21 136:25
60:2 62:25	216:4 219:9,12	137:1
<b>biomagnification</b>	235:11 240:7	<b>Brady</b> 3:14 4:18
48:25 70:21 71:1	<b>blend</b> 90:20	32:21 46:22,24
100:16	<b>blindsided</b> 37:6	89:10,12 140:6,8
<b>biomarker</b>	<b>block</b> 184:12	141:8 179:17,19
170:4,8,10	<b>blood</b> 132:18	180:19 213:15,18
<b>biomarkers</b> 170:4	<b>blue</b> 86:8,20	216:11,13
171:13,23	<b>BMS</b> 100:20 102:4,20	242:15,18
<b>biomass</b> 239:19	105:11	<b>break</b> 77:4 87:8
<b>biosediment</b> 51:6	<b>Board</b> 239:22	88:17 91:6
<b>biota</b> 97:12	<b>bodies</b> 6:1,23	138:10 139:6,9
<b>biotic</b> 97:23	213:12	180:12 207:8
<b>biotransformation</b>	<b>body</b> 6:1 7:10 22:23	212:22 215:10,15
49:1 56:9 63:7	37:11 61:22	238:18 242:13
64:5 161:24 165:12	69:16 96:23	243:12 244:1
<b>bird</b> 60:18 112:25	112:3 113:9 132:14	<b>breakdown</b> 21:7
129:25 170:20	145:24 146:2	<b>breaks</b> 111:13
171:1 179:9	157:10,20	235:11
<b>birds</b> 49:24 53:22	158:2,4 161:20	<b>breathing</b> 54:4,5
60:1,7,23	169:15,18	<b>Brendan</b> 65:24
61:3,17,19 62:1	170:2,7 171:3	70:8,11 77:19 81:1

88:1	40:14 82:23	154:7 192:1 230:8
<b>Brian</b> 133:13 136:21	<b>buried</b> 39:18	<b>captured</b> 97:11
173:6	<b>Burkhart</b>	227:14 228:6,14
<b>brief</b> 88:19 90:16	26:5,14,15,17,25	230:15
215:17	27:6,7,11	<b>captures</b> 123:22
<b>briefly</b> 48:21 80:25	<b>busy</b> 52:7	<b>capturing</b> 222:16
103:14 223:20	<b>But...are</b> 42:16	<b>carbofuran</b> 133:22
<b>bring</b> 9:2 53:22	<b>but...but</b> 14:11	<b>carbon</b> 26:7,10 27:4
115:3 125:2 131:11	63:4 74:18	59:9 70:15,17
137:3 139:20,25	<b>but...or</b> 112:25	<b>care</b> 101:24
159:8 161:9 218:10	<b>but...so</b> 76:11	<b>career</b> 52:7
<b>bringing</b> 59:17	<b>by...by</b> 52:11	<b>careful</b> 63:18
161:24 217:19	<b>by...this</b> 18:13	68:7,19 69:11 78:2
237:8		80:21 134:24
<b>brings</b> 61:1 126:11	C	233:20 235:20
<b>broad</b> 44:21 239:8	<b>calculate</b> 9:10,11	<b>carefully</b> 54:24
<b>broader</b> 122:9,11	60:15,21 65:4,7	58:6 103:22 138:2
129:3 219:9	147:7	<b>Caribbean</b> 182:15
<b>broken</b> 172:5	<b>calculating</b> 102:4	<b>caribou</b>
<b>brought</b> 40:13 49:22	<b>calculation</b> 3:24	118:13,16,17
51:12 57:11	19:9	<b>Carlo</b> 193:3 214:23
73:15 74:1	<b>calculations</b> 69:7,9	<b>carnivore</b> 118:3
128:10 135:15	115:13	<b>carnivores</b> 117:20
138:14 165:5 174:8	<b>calibrate</b> 54:13	134:14
<b>Brown</b> 186:12	<b>calibrating</b> 220:4	<b>Carolina</b> 210:15
<b>BSAF</b> 146:22	<b>calibration</b> 54:11	<b>carpet</b> 208:10
<b>Bucher</b> 141:12	57:5	<b>carried</b> 116:5
168:11,12,13 171:7	<b>campaign</b> 197:23	200:25
<b>Buchman</b> 58:14	<b>campaigns</b> 197:16,20	<b>carrier</b> 21:1
<b>buck</b> 219:13	<b>can...and</b> 16:3	<b>carriers</b> 241:25
<b>buffer</b> 228:15	<b>can...I</b> 85:15	<b>carries</b> 106:12
<b>build</b> 121:6 125:21	<b>can...people</b> 25:25	<b>carrot</b> 95:6
<b>building</b> 223:6	<b>can...this</b> 116:9	<b>carry</b> 69:8 89:6
<b>buildup</b> 94:1	<b>can...was</b> 51:5	<b>case</b> 16:18 78:20,22
<b>built</b> 97:13 124:9	<b>Canada</b> 5:22	80:13 81:3 82:5
<b>bulleted</b> 67:17	181:20 182:9	95:23 100:12,23
<b>bullets</b> 217:11	210:17	102:4 104:3
<b>bunch</b> 146:7,18	<b>Canadian</b> 183:2	106:6 118:14
148:9,20 149:2	184:6 193:21	131:25 142:17
156:13 160:11	194:15 195:16	153:8 154:19 158:6
208:12	<b>canopy</b> 126:2	178:23 181:13
<b>burden</b> 170:7 177:10	<b>capabilities</b> 111:20	182:3 183:17
<b>burdens</b> 169:15,18	242:23	194:16 210:7,22
170:2	<b>capability</b> 81:5	213:24 231:18
<b>burial</b> 6:9,15,17,22	203:14	234:9
7:11 39:13,14,21	<b>capture</b> 124:12	<b>cases</b> 20:6 21:19
		22:7 43:21 79:10

85:21,22 98:18	<b>certainly</b> 6:19,24	161:18 172:9
117:22 148:22	22:17 37:25	173:11 174:14
153:6 156:7 157:17	43:4,20 44:2	236:12,13
158:16 159:17	46:5 62:19 72:12	<b>changing</b> 77:17
160:5 169:25 170:7	85:15 86:15	236:16
171:24 181:14	96:16 101:17 102:6	<b>chapter</b> 60:8 189:8
190:1 194:8,9,20	115:3 119:1	<b>characteristic</b> 58:9
232:15 234:22	122:4 123:25	77:10 185:15,16
<b>Catalan</b> 80:6	135:14,25 138:20	189:23 192:6
<b>catch</b> 12:3 77:16	163:16 184:15	194:3,18 198:3
<b>categories</b> 242:3	209:7,18 215:10	<b>characteristics</b>
<b>category</b> 111:1	<b>cetera</b> 133:10	2:12,25 47:7,16,25
<b>caught</b> 132:8	182:22 190:24	122:7 139:17
<b>cause</b> 105:7	211:10	140:22 153:5
157:23 220:7	<b>chain</b> 101:24	179:21 201:10
<b>causes</b> 162:10	102:3 118:13 126:9	217:2
<b>causing</b> 105:15	127:3,10 132:16	<b>characterization</b>
<b>caution</b> 52:25 64:11	<b>chains</b> 118:6,24	45:21 125:9 199:3
102:10 166:19	<b>Chair</b> 2:18	<b>characterizations</b>
<b>cautions</b> 210:22	<b>chairman</b> 3:18 18:10	7:19 232:13
<b>cautious</b> 64:4	213:24	<b>characterize</b> 7:14
103:10 169:22	<b>challenge</b> 54:11	44:21 218:4
<b>caveat</b> 69:10	61:2 118:8,9,21	<b>characterized</b>
<b>caveats</b> 56:15	163:25 180:6 200:7	216:25 233:21
<b>CBR</b> 145:23	218:4,10 221:8	<b>characterizing</b>
146:1,2 149:21	222:1 223:8 228:4	125:14 158:1 218:1
<b>CBRs</b> 149:2 150:12	<b>challenges</b> 57:5	231:9
154:17 174:23	217:25 218:1	<b>charge</b> 3:8,9 5:14
<b>CD</b> 141:17	219:25 223:18	8:6,11,15 25:6
<b>CDRs</b> 69:8	<b>challenging</b> 129:2	46:19,22,24
<b>centimeter</b> 179:6	162:7 179:6	88:23
<b>centimeters</b>	<b>chance</b> 3:12 65:24	89:2,5,9,12
43:19,20 192:12	88:13 94:14,16	137:12,17 139:19
<b>Central</b> 204:4	204:11 216:3 227:5	140:5,8
<b>centrifugation</b>	243:12	179:16,19 180:22
21:17 25:16,17	<b>chances</b> 68:13	215:16,20,24 216:1
<b>centrifuge</b> 21:18	<b>change</b> 42:13	221:11 243:19
<b>certain</b> 14:19	135:5,7 137:15	<b>chasing</b> 77:15
30:7 45:2 82:15	143:16 147:24	<b>check</b> 177:23 179:3
87:13 94:10 113:23	154:17 155:17	<b>chem</b> 91:24
117:9 128:4	192:20 230:1	<b>chemical</b> 6:6
131:6 134:7	236:16	9:12,20,21 11:8
166:1 172:23	<b>change...change</b>	13:5 14:5,10,14,18
209:25	14:21	16:1,4,8,9,13,15
<b>certain...some</b>	<b>changed</b> 172:24	17:16 23:13
54:14	<b>changes</b> 14:19 36:20	28:15,23 29:2 35:4
	42:7 60:12 155:2	37:13,15,21

38:5,11 39:17,20 155:12 168:20 **choices** 177:16  
 40:8 47:4 49:11,18 181:20,25 182:2 **choir** 164:8  
 52:19 56:8,19 63:2 184:9,13,18 **cholera** 148:24  
 64:7 67:2 84:6 185:4 186:18,25 **Cholinesterase**  
 91:18,25 187:5,6,15,17,21,2 170:6  
 92:12,15 93:18 3,25 **choose** 179:10  
 96:12 107:7 110:18 188:1,2,9,14,16,23 180:15 215:3  
 114:14 124:17 189:16,17,20 **choosing** 30:13  
 132:13 140:15,20 190:3,4,5 118:22  
 144:18 175:17 191:9,11,12,16 **chorines** 203:6  
 182:5 183:20,23 192:25 193:8 196:6 **Christian** 2:4,6  
 184:21 185:19 198:7,17 199:3 **Christina** 173:7  
 186:5,17,20,24 200:11,18 201:21 **chronic** 60:16 158:9  
 189:1 191:4 205:10 211:22,25 159:9,11,13,15  
 193:5,13,14,15 212:12 217:23 161:8 162:10,23  
 195:21,23 218:7 219:11 163:1,17,23  
 196:2,5 198:24 221:17 223:15,24 174:21,24  
 201:7,23,25 229:14 230:2 175:9,12,15,18,21,  
 205:13,22 206:5 232:2,25 233:7 24 176:16 236:5  
 210:10 211:17 234:16 235:21  
 232:8 236:1 237:7 239:9 **Chub** 186:11  
**chemical...to** 131:1 **chemical's** 189:2  
**chemicals** 206:4  
 15:15,16,22 **chemicals...and**  
 16:11,21,23 124:21  
 20:25 24:5 33:13 **chemicals...I**  
 35:12,13 39:23 124:23  
 47:6,9 51:13 **chemicals...the**  
 54:12,22 55:6 57:7 128:21  
 58:7,16 59:15 **chemicals...tying**  
 64:11 66:25 34:11  
 67:22 68:5 81:16 **chemical-specific**  
 83:9,15,18 52:17  
 96:15,18 **chemist** 23:22 205:7  
 97:6,9,16,23 **chemistry** 194:13  
 99:3,10 101:6 205:9  
 104:24 106:5 **chemists** 205:18  
 108:16 208:13  
 109:3,9,13,21 **Chemodynamics** 8:25  
 110:13 112:17 **chime** 33:5 141:12  
 113:20,25 114:12 **chlordane** 114:13  
 122:6,10,15,23 182:22  
 123:14,25 **chlorinated** 101:6  
 124:4,13,14 131:17,25  
 125:8,16 126:20 **chlorine** 182:20  
 129:5 131:2,22 **chlorines** 183:7,15  
 132:22 134:9 135:2 **choice** 214:14  
 140:10 154:16

<b>classic</b> 123:24 126:15 137:4 182:21 196:16 199:7	<b>coefficients</b> 15:23 20:9 36:9 96:5 98:8 107:1 108:17	94:15 120:25 132:19 134:8,16 171:2 197:25 206:15 209:25 230:20
<b>classically</b> 124:25 129:5	<b>Cohen</b> 3:19 4:8,11 139:23 180:12	<b>coming...or</b> 7:2
<b>classified</b> 188:6,15	<b>coincide</b> 73:6	<b>commend</b> 217:18
<b>classify</b> 186:25	<b>cold-blooded</b> 58:19	<b>commended</b> 235:2
<b>clay</b> 41:16	<b>collaboration</b> 72:6 226:22	<b>comment</b> 4:12 5:4 9:4 13:25
<b>clean</b> 43:13,14,18	<b>colleague</b> 130:8	15:9,12 19:3 21:21 25:18 27:16
<b>clear</b> 13:6 46:16 68:1 89:1 103:5 236:20	<b>colleague...</b> <b>former</b> 130:7	30:22 32:19 44:10 47:22 48:1 49:5 50:23 63:21 70:20 77:7 80:25 81:21 86:3 89:25 90:4,10 102:13 103:15 105:16 110:20 115:23,25 116:13 117:7 121:7 131:14 140:24 141:3 163:3 165:16 168:18 170:20 175:17,20 177:15 180:7,13 191:14 209:4 211:12 213:19,22 216:24 226:15,23 234:18
<b>clearance</b> 79:13 103:12 112:23 113:4,7,12	<b>colleagues</b> 33:5 53:13 92:6 119:10 181:7 207:15 241:6	<b>commentaries</b> 180:16
<b>cleared</b> 113:9	<b>collect</b> 178:8	<b>commenting</b> 168:18
<b>clearly</b> 48:17 159:5 160:23 240:3	<b>collected</b> 194:13	<b>comments</b> 2:15 3:12 4:23 5:1,14 7:20 8:13,18 15:4 21:22 31:19 42:17,19 48:13 50:9,21 65:19,22,24 66:12 67:16 73:17 77:5,21 81:23 90:16 95:15 99:14,17 104:4 110:25 119:17 129:16 133:1 139:25 165:23 172:1,4 176:14 179:12 204:12 213:22
<b>clever</b> 13:21	<b>collecting</b> 160:25	
<b>climate</b> 236:16	<b>collection</b> 44:24	
<b>close</b> 13:22 88:4 137:9 138:22 194:9	<b>colloidal</b> 74:8 237:4	
<b>closer</b> 11:13 25:15 157:25 186:20	<b>color</b> 25:19	
<b>cloud</b> 195:21	<b>co-loyal</b> 21:13	
<b>clues</b> 196:8	<b>Columbia</b> 87:11	
<b>cm</b> 38:9	<b>column</b> 33:22 37:17 38:7 192:13	
<b>cm/hour</b> 42:3	<b>columns</b> 193:23	
<b>co...of</b> 19:13	<b>combination</b> 47:10 101:21	
<b>coastal</b> 32:10	<b>comes</b> 12:3 13:8 37:16 38:15 39:1,15 85:11 86:18 104:11 156:25 198:19 199:20 207:10 212:24 228:13	
<b>coating</b> 16:14	<b>comes...and</b> 9:18	
<b>code</b> 46:2	<b>comfort</b> 92:22 95:21	
<b>co-discussants</b> 48:10 90:18 104:23 217:9 223:11	<b>comfortable</b> 119:16,20	
<b>coefficient</b> 9:10,24 10:2,15 12:3,19,20 15:18,25 16:21 26:9 27:25 28:7 29:5 30:7 187:4 192:17,18	<b>coming</b> 7:2 14:5 18:17 41:10 46:16 51:7 58:4 75:24 91:13	
<b>co-efficient</b> 149:22 186:15,16 187:3,15,17		

220:13,18,24	107:16 110:8	169:11 170:22
223:20 231:3	128:12,16 185:7	173:25 217:5
237:22 238:3	221:2 222:16,19	<b>compounds...first</b>
242:12 243:8 244:2	223:2	100:11
<b>common</b> 167:14	<b>complicated</b> 231:3	<b>comprehensive</b> 49:19
<b>community</b> 131:5	<b>compliment</b> 24:12	50:2 84:16 203:25
<b>comparable</b> 16:6	<b>component</b> 71:19	<b>compromised</b> 157:5
<b>compare</b> 198:6,17	165:4,7,11,14	<b>computer</b> 185:12
<b>compared</b> 17:7 34:22	<b>components</b> 242:1	187:12
52:12 89:23 148:19	<b>compose...it's</b>	<b>concentrate</b> 94:6
189:15,22 221:5	128:3	<b>concentrates</b> 93:20
<b>compares</b> 189:8	<b>composed</b> 128:3	<b>concentration</b>
<b>comparison</b> 81:2	<b>compound</b> 71:17	9:23 10:11 20:21
<b>comparisons</b> 81:16	79:19 82:8 87:20	21:3 22:3,5
169:16 189:11	94:14 100:14,18	25:15,22,25
<b>compartment</b> 11:9	101:1 105:11	28:1,8,11 44:16
69:18,21,22 134:10	124:10 143:9	45:6 59:15
165:8 237:18	145:11 146:6	76:4,6 93:15,25
<b>compartmental</b> 165:7	152:14 153:3	94:11 105:25
<b>compartmentaliziatio</b>	154:19	142:18
<b>n</b> 165:3,15	155:16,22,23 156:3	143:12,15,16,24,25
<b>compartmentalize</b>	158:16 164:19	146:23 147:22
117:16 164:24	169:5 170:22	148:16 152:4
<b>compartments</b>	178:23,25 204:22	153:19,21 160:2
69:17,24 80:24	205:13 238:22	161:13
96:6 97:24 126:4	242:1	162:4,8,25
134:24	<b>compounds</b> 23:15	169:12,14 173:18
135:2,5,10	26:1 36:22 53:3	175:4 177:10
168:20 192:9	73:1,11 74:4,16	178:11 185:17
<b>complete</b> 4:21	75:2,16 77:25	190:23 193:24
89:2 141:16	78:12 80:16,23	195:1,2 213:2
<b>completed</b> 88:22	100:6,11 101:7	<b>concentration-based</b>
215:19	109:6,23,25	68:21,22
<b>completely</b> 29:2	110:2,3	<b>concentrations</b>
34:10 38:9	111:10,18,22 113:2	6:4 9:17 20:18
111:13 230:9	115:4,12 121:1	21:11 24:10 28:6
<b>completing</b> 3:9	131:17,25 132:8	55:11 60:12,15
<b>complex</b> 43:24	141:20 142:12	61:21 70:16
44:1,2 46:12 57:17	145:2,3,10,13	77:14 78:8 80:14
135:9 191:3 199:18	146:20 147:18	85:12 87:12
202:19 222:25	149:7,8 150:9	96:12 112:4 120:24
<b>complexes</b> 85:4	151:5,6 152:23	127:7 145:16,19
<b>complexities</b> 100:10	153:3,14 154:10,14	153:23 154:4
103:20 202:19	155:5,18,19	161:11,20
221:8 223:7	156:9,17,20 157:23	162:12,18,22 163:9
<b>complexity</b> 13:11	158:3,17 160:17,18	172:8 177:11
82:12 85:8	164:11 165:13	190:20 194:2,19
	166:14 167:11	

225:25	<b>connect</b> 162:9 163:2	<b>considerations</b>
<b>concept</b> 16:25	200:13 205:24	77:24 87:5 102:15
57:4 59:14 71:12	212:25	<b>considered</b> 8:3
144:10 145:25	<b>connected</b> 59:3	47:14 58:6 89:16
173:16 184:12	<b>Connecticut</b> 114:3	100:6 127:2
<b>concept...is</b> 84:23	<b>connection</b> 117:12	133:6 145:13
<b>conceptual</b> 95:10	241:13	151:10 153:18
109:1 122:22	<b>connections</b> 88:6	158:15 170:5
123:21 124:2 125:9	117:8 162:14	180:5,15 181:8
126:13,25 127:18	<b>Connelly</b> 113:7	183:19 200:3,7
137:14,20 213:10	<b>consensus</b> 63:7	232:24 236:19
218:14,16,18	108:5 120:2	238:16
232:19	<b>consequence</b> 79:8	<b>considering</b> 40:9
<b>concern</b>	<b>consequently</b>	127:5 132:11
61:8,9,13,15	74:13 75:6	139:18 140:22
88:2 128:21 140:18	<b>conservation</b> 208:23	171:14 181:15
226:21 236:18	224:18,19 225:2,13	216:20 223:18
<b>concerned</b> 44:24	<b>conservative</b> 6:20	234:16 238:8
79:22 83:23	40:3,5,6,8 43:7	<b>considers</b> 47:16
101:3 177:9	63:14	<b>consistent</b> 25:1
<b>concerns</b> 128:19	<b>consider</b> 6:21 7:4	120:10 140:2
163:22 179:25	47:4,22 70:19	149:21
<b>concise</b> 46:16	79:5,24 80:22	<b>consistently</b> 53:5
<b>conclude</b> 122:2	82:11 83:6 84:7	<b>constant</b> 28:7 57:18
<b>concluded</b> 244:5	90:1,2 91:23 98:10	58:12 63:10,17
<b>conclusion</b> 190:25	116:19 118:17	68:11,13,16
191:1,8	130:19 132:9	69:2,3,20 79:9
<b>conclusions</b> 18:14	135:2,7 148:21	188:17 192:22
<b>conditions</b> 18:21,23	151:12 154:22	195:8 206:5
19:5 31:16 195:8	157:7,13,14,16,21	<b>constantly</b> 77:15
<b>conduct</b> 150:10	158:7,10 159:4	<b>constants</b> 52:13
<b>conducted</b> 197:21	170:3 174:13	54:15 56:6,24
208:22	181:14 182:17	58:16 68:3,7 78:10
<b>confidence</b> 52:14	185:1 196:4	<b>constituents</b> 170:24
147:2 148:17	199:9 202:11	<b>constrained</b> 126:14
162:19 203:15	207:17 216:1,9	<b>constraints</b> 9:16
219:5	231:18,22	97:22
<b>confound</b> 151:14	<b>consider...</b>	<b>construct</b> 104:18
<b>confounding</b> 151:7	<b>considering</b> 71:1	128:13
153:17	<b>considerable</b> 161:21	<b>consume</b> 133:15
<b>confront</b> 240:12	<b>considerably</b>	<b>contacts</b> 226:2
<b>confused</b> 137:19	55:24 161:12	<b>contaminant</b> 152:8
<b>confusing</b> 156:21	<b>consideration</b> 60:23	161:17 177:25
<b>congeners</b> 64:1,3	112:6 121:12	<b>contaminants</b> 117:10
102:18,19 112:14	126:24 172:18	181:17,21 182:9,10
<b>conjugated</b> 155:2	175:13 231:17	186:19 197:17
<b>conjunction</b> 36:13	232:20	<b>contaminated</b>

12:21 13:3	221:3,4,5	<b>could...erosion</b>
43:9,12,21 239:18	<b>conversion</b> 172:12	42:3
<b>contamination</b>	175:24	<b>count</b> 219:7
186:3,4,5,10	<b>conversions</b> 172:20	<b>country</b> 206:17,18
190:14 213:7	<b>convinced</b> 174:18	<b>couple</b> 19:3 33:17
<b>content</b> 17:21 26:10	<b>cooking</b> 13:6	63:15 70:10
55:25 76:22	<b>Cooperative</b> 225:2	72:23 78:7 81:24
77:10 138:14 197:1	<b>cop</b> 65:8	95:9,11 154:2
<b>contents</b> 56:4 79:17	<b>copies</b> 139:22	161:6 164:4
101:12 103:8	<b>copper</b> 70:12,16	172:3 193:2 202:14
<b>context</b> 40:20 98:11	<b>copy</b> 9:2	231:12
121:20,24 141:3	<b>Cordona's</b> 166:11	<b>couplers</b> 156:16
174:3,22 178:20	<b>core</b> 51:18 149:13	<b>course</b> 8:23 15:20
191:2,5 243:9	<b>corn</b> 232:25	20:11 27:19
<b>continent</b> 128:9	<b>corner</b> 187:22	45:12 46:19
<b>continental</b>	<b>Corps</b> 150:21,24	49:24 53:6
118:25 128:1	<b>corranamids</b> 80:8	56:14,16 65:6 89:7
197:21	<b>correct</b> 3:24 4:9	92:2 112:1
<b>continentally</b> 237:9	8:16 11:3,7	117:12 143:6
<b>continue</b> 2:9 4:22	38:21,24 66:11	151:6,12 152:15
39:24 67:9	68:23 104:22 121:2	154:9,14,20 160:20
<b>continuing</b> 22:22	191:2,5 213:21	165:12 180:15
30:2 33:23	241:24	182:20 184:23
<b>continuous</b> 185:24	<b>correct...that</b> 11:5	191:5 210:18
192:23	<b>corrected</b> 11:19	<b>cover</b> 189:18 203:19
<b>continuously</b> 229:9	<b>correctly</b> 66:9	228:10,20 230:10
<b>contrast</b> 60:9 221:3	105:21	243:21
<b>contribute</b> 126:8	<b>correlate</b> 170:10	<b>coverage</b> 122:9,11
155:6 156:7 181:17	<b>correlated</b> 178:1	125:1 213:15
204:11	<b>correlation</b>	<b>covered</b> 46:15 81:25
<b>contributed</b> 46:11	104:25 171:16	82:1 133:25 134:3
99:9 204:10 243:17	<b>correlations</b>	<b>covers</b> 71:22
<b>contributes</b> 128:5	26:20 202:25	<b>cow</b> 111:19
<b>contribution</b> 125:4	<b>correspond</b> 166:14	<b>coworkers</b> 194:12
<b>contributions</b> 88:12	<b>corresponds</b> 165:21	195:18
179:15	<b>co-solvent</b> 21:23	<b>create</b> 223:17
<b>contributors</b> 44:9	22:4	<b>creates</b> 59:24
<b>control</b> 125:10	<b>co-solvents</b> 19:11	<b>credible</b> 191:2
126:7	20:5,16,19 21:25	<b>criteria</b> 141:19
<b>controlled</b> 51:9	56:17	145:16,17,18
<b>controls</b> 158:20,21	<b>Costa</b> 193:21	148:24 173:4
<b>convenience</b> 23:25	<b>Cotrin</b> 189:12	<b>critical</b> 61:22
<b>conventional</b> 30:16	193:10	66:5,8,10 69:16
<b>converge</b> 149:3	<b>cotton</b> 232:25	73:21 75:25
<b>conversation</b> 46:9	<b>could...could...</b>	76:10 145:23 146:2
125:18 217:12	<b>is</b> 42:2	165:17,20
		<b>Critters</b> 236:8

**crop** 7:8 95:5 79:13 163:17 171:17 181:10  
**crops** 122:16 **curves** 102:22 184:16 202:22  
233:1,16 **cut** 100:1 106:16 221:5 243:18  
**cross** 211:18 108:21 **days** 14:5,6 19:4  
**cross-correlation** **cutoff** 27:12 49:20 67:24 69:3  
105:14 76:10 94:21 100:13 72:22 78:7  
**cross-cutting** **cycle** 124:14,15 147:20 154:12,18  
137:18 138:6 173:12 158:8 184:21  
**crossing** 208:11 **cycles** 158:23 191:15 198:15  
**cross-over** 119:6 188:24 214:20,25 215:1  
**crude** 184:23 **cyclic** 220:6 217:12 227:1  
**CTAC** 184:18 189:5  
191:7 193:10  
205:16  
**CTD** 185:18 190:6  
191:12 193:18  
194:8  
**CTDs** 194:6,21,22  
198:6  
**cucumber** 113:23  
125:20  
**cucumbers** 125:20  
**cucurbits** 113:24  
114:5 115:25  
**cumulative** 147:6  
**CUPS** 183:2 196:24  
199:18  
**current** 36:18  
44:17,18 67:19  
90:4 116:13  
117:4 123:3 124:18  
126:13 145:9 183:3  
188:13 194:17  
204:20 219:6 227:9  
242:5  
**currently** 7:14 63:9  
67:13 89:13  
144:7 179:22  
183:1,7,11,15  
184:4 196:15,21  
197:12 199:6,12  
203:6 207:3,5,23  
**currents** 184:10  
185:2 199:25  
211:22  
**curve** 17:4,6,16  
23:11 24:24

---

D

---

**daily** 60:22  
**Dan** 72:19  
**dangerous** 79:10  
**dangers** 135:12  
**Daniel** 48:12  
**data** 3:20,21,25  
12:21 17:4 36:4  
37:1 41:1,2  
47:17 52:10,12  
54:13 60:20  
63:12 73:8 75:23  
83:7,9 84:6  
95:12 113:3  
120:4,15,16,18  
135:25 148:6  
150:20,22,24  
151:4,6 157:10  
159:9,23  
160:11,22,25 162:1  
171:19 172:7,12,22  
173:20 174:15  
175:8 176:3 179:24  
183:18 193:5,17,19  
197:14,24 198:2  
202:3,6,11  
203:13,19 204:21  
209:18 223:3  
224:11 225:9  
226:22  
**Dawson** 214:2  
**day** 2:21 34:5 38:16  
87:21 139:13  
143:16 167:2  
168:14 169:17

171:17 181:10  
184:16 202:22  
221:5 243:18  
**days** 14:5,6 19:4  
49:20 67:24 69:3  
72:22 78:7  
147:20 154:12,18  
158:8 184:21  
191:15 198:15  
214:20,25 215:1  
217:12 227:1  
**day's** 3:13  
**DDE** 113:8  
**DDT** 182:21 201:4  
**dead** 157:5 236:9  
**deaf** 166:1  
**deal** 51:25 64:7  
85:23 88:15  
90:20 92:18 109:18  
110:12 128:20  
156:24 221:9,14  
229:16 235:13,22  
236:7,14  
237:3,6,12  
**dealing** 50:2,7 67:8  
83:12 91:21 109:17  
119:7 121:25  
131:21 185:12  
219:9 237:5  
**deals** 75:10  
**dealt** 236:3  
**death** 106:7  
**debatable** 112:18  
**debate** 94:12  
**decade** 183:25  
**decent** 68:3  
**decide** 7:5 41:23  
91:4 93:7 222:18  
**decided** 200:8  
215:11,25  
**deciding** 120:21  
**decision** 91:3  
124:18 128:20  
215:13 232:14  
**decisions** 129:1  
**decisions...and**  
128:19

<b>decoupled</b> 97:6	196:6	<b>deposited</b> 183:21
<b>decrease</b> 102:25	<b>degraded</b> 64:8	190:15
161:20	<b>degrading</b> 64:1	<b>deposition</b> 31:14
<b>decreased</b> 236:12	<b>degree</b> 118:3 166:1	41:4 89:14
<b>decreases</b> 195:3	<b>degrees</b> 192:22	94:17,23 107:10,12
<b>decreasing</b> 187:19	<b>Delarco</b> 167:3	113:21 114:18
206:5	<b>delayed</b> 235:18	115:16 116:24
<b>deems</b> 141:2	<b>deliberate</b> 216:4	120:23,25 180:4
<b>deer</b> 114:22	<b>deliberations</b>	183:3,8,23 184:8
<b>default</b> 35:11	133:23 180:14,20	185:4,23 188:24
<b>defeats</b> 160:14	<b>deliver</b> 200:20	195:24 196:1 200:7
<b>defensible</b> 145:15	<b>delorme</b> 5:15,16	212:2,6,9 213:11
<b>defer</b> 41:5 90:17	8:1,20 25:2,6,8	<b>depth</b> 29:24
92:5	81:23,24	30:7,9,13 35:1
<b>define</b> 27:4 40:23	84:13,22 135:11,12	192:12 215:6
63:1 74:9 103:21	172:3 231:5,6	<b>derivation</b> 24:24
129:24 141:23	235:3	<b>derive</b> 40:24 178:11
145:20,23 146:3	<b>Delorme</b> 217:10	<b>derived</b> 56:23 63:17
159:5	<b>DeLorme's</b> 49:5	111:9 141:6 151:25
<b>defined</b> 27:7	<b>demand</b> 51:23	<b>derives</b> 101:22
64:23 101:7	<b>demands</b> 9:24	<b>deriving</b> 167:1
130:4 144:8 178:23	<b>demonstrating</b> 74:25	<b>Derrick</b> 194:12
186:14	<b>Department</b>	<b>describe</b> 55:15
<b>defines</b> 91:18	224:16,24	122:14 169:24
<b>definie</b> 80:10	<b>depend</b> 23:12 221:18	<b>described</b> 196:20
<b>defining</b> 31:7	<b>depend...now</b> 27:24	199:8 211:23
160:23	<b>dependence</b> 79:12	219:20
<b>definitely</b>	80:2 103:12	<b>describes</b> 216:14
46:7,21 58:5	169:13,14 174:21	<b>description</b> 242:7
78:1 114:10	<b>dependency</b> 147:18	<b>descriptions</b>
156:2 157:7,15	154:12	191:3 211:19
164:12 168:4 234:6	<b>dependent</b> 153:16	<b>descriptors</b> 197:10
<b>definition</b> 64:22	154:11 156:24	<b>Designated</b> 2:7
145:23 205:8	157:2 170:2,9	<b>desirable</b> 51:22
<b>definitions</b> 126:15	174:19 177:11	<b>desk</b> 227:3
<b>definitive</b> 206:1,2	<b>depending</b> 26:7	<b>desorbtion</b> 23:18
<b>degradants</b> 63:18	27:13 29:23 30:6	<b>desorption</b> 13:17
64:10,13	37:21 190:7	16:17 28:16
<b>degradation</b> 14:25	234:7 237:14	34:22,24 36:4,8
184:16 185:21	<b>depends</b> 27:25 28:10	<b>detail</b> 59:19
192:18 193:6 195:4	59:19 65:6 85:19	73:16 88:10 109:11
198:14 199:12	91:8 122:4	125:16,19
<b>degradation/</b>	152:14 201:6,7,12	127:12,21 128:6,15
<b>metabolism</b> 98:8	<b>deployed</b> 193:21	141:20 169:23
<b>degradations</b> 185:5	<b>deposit</b> 188:9	223:12
<b>degrade</b> 183:24	201:24	<b>details</b> 31:3
		50:10 66:5 221:6

<b>detection</b> 205:22	118:8 140:16 171:2	233:5
<b>deter...determining</b> 129:15	<b>dietary</b> 53:19 60:22 71:13,19 152:5	<b>different...from</b> 121:16
<b>determination</b> 231:15	<b>diets</b> 103:21	<b>differently</b> 83:17 144:8 152:10
<b>determine</b> 29:2 45:17 69:20 71:13 80:10 91:25 160:3 226:18 229:12	<b>difference</b> 10:21 39:10 93:16 103:9 111:18 138:3 145:6 159:24 190:9,17 215:1	<b>differs</b> 234:7 <b>difficult</b> 30:3 41:6 45:2 60:3 86:24 103:24 105:1 129:13 164:25
<b>determined</b> 195:18	<b>differences</b> 75:14 112:9 143:7 170:16	<b>difficulties</b> 180:3 200:6
<b>determines</b> 131:22	190:1,2,18	<b>diffuse</b> 43:22
<b>determining</b> 146:21 165:16	194:20,21	<b>diffusion</b> 30:6,11
<b>develop</b> 7:17 120:2 127:19 129:17 160:21 193:11 225:10,11 231:2	<b>different</b> 6:5 12:14 13:14 14:7,21,22 15:14 27:24 29:14 31:16 35:23 39:13 40:21 45:11,16 50:25 56:4 57:21 60:14 63:23 64:24 68:12,14 69:16 73:23 78:17 81:4,10 83:16 84:24 97:17,20 99:9 108:5,16 109:4,23 111:20,21 112:15 116:18,20 117:1,6,13 120:1 121:16,18 131:7,8 143:6 144:13,16,18,24 145:21,25 146:3 147:4 148:5,23,25 152:8 154:8 157:15 166:12,18 167:8 172:9 175:5 183:14 188:4 194:8 196:15 204:7 205:2 219:1 221:7 222:16 223:23 224:2,6,14,25 226:16,17,18 228:14,19,20,24 229:25 230:3,9,10,19	<b>digs</b> 39:20 <b>dilution</b> 161:18 <b>dilutions</b> 145:3 <b>dimension</b> 235:19 <b>dimensionalist</b> 34:21 35:2 <b>dioxin</b> 156:15 <b>dips</b> 201:9 <b>direct</b> 47:4 51:2 89:14 116:24 118:15 131:1 140:12 184:7 200:22 <b>direction</b> 33:10 116:15 121:16 168:1 187:18 217:21 <b>directions</b> 78:16 <b>directly</b> 91:15 112:5 133:8,14 171:2 199:20 227:22 228:10 <b>disagree</b> 108:24 <b>disagreement</b> 107:23 <b>disappears</b> 64:8 <b>disc</b> 214:2 <b>disciplines</b> 208:12 <b>disconnect</b> 162:25 <b>discover</b> 241:20 <b>discrimination</b> 114:10 <b>discuss</b> 46:3 63:6
<b>developed</b> 26:20,21 57:3 64:12 81:13 89:23 101:5 103:17 107:6 110:10 111:10 115:19 120:24 122:3,22 159:18 170:18 193:1 202:18 235:23		
<b>developers</b> 222:5		
<b>developing</b> 75:12 98:22 209:23 218:13 220:4		
<b>development</b> 83:6 107:3 111:16 120:9 173:9 176:20 219:18 239:23		
<b>developmental</b> 76:21 165:21		
<b>deviation</b> 23:17 148:14		
<b>devices</b> 45:4		
<b>DFO</b> 244:3		
<b>die</b> 157:3,4 239:19		
<b>died</b> 169:19		
<b>diet</b> 48:24 58:1,3 62:8 63:1 86:22		

**discussant** 48:6 189:23 194:18 57:22 66:2,9,10  
 90:8,11 92:10 200:25 206:14 68:14 82:18  
 141:9 168:10 211:23 83:25 109:10,11  
 180:17 206:12 **distinct** 138:18 112:6 113:22 114:2  
 217:6 223:14 162:21 117:24 119:23  
**discussants** 4:25 **distinction** 159:10 159:20 167:22  
 46:20 65:24 77:5 **distinctly** 178:17 189:11  
 138:15 161:4 168:7 116:18,20 194:11 200:2 202:9  
 204:9 215:23 **distributed** 86:8 203:4,5,6 204:6  
**discussed** 20:10 135:3 148:10,11 218:3 222:8  
 21:24 33:19 168:24 227:4 231:10  
 49:25 54:20 **distribution** **done...and...and**  
 164:4 165:14 27:19 80:15 94:5 63:20  
 171:10 175:12 99:2 103:3 146:8 **Donnelly** 48:11  
 181:6 225:16 147:7 221:24 71:24,25 72:18  
 227:15 **distributions** **donor** 197:9  
**discussing** 133:12 146:25 160:9 **Don's** 11:7 23:3  
**discussion** 3:9 **diverse** 217:20 **don't...don't** 117:2  
 32:18 49:20 50:5 **diverted** 9:20 **don't...I** 81:14  
 55:3 56:14,16 **divide** 146:12 **don't...they** 66:21  
 64:18 74:6 89:5 **divided** 34:25 **don't...you** 106:7  
 116:14 135:15 185:24 186:6 **door** 173:14 198:24  
 137:2 138:19,20 **dividing** 81:7 160:1 **dose** 94:8 111:25  
 140:3 151:17 **Division** 32:4 134:16,25 144:22  
 206:10 215:6,19,20 239:25 145:1 149:13,16  
 223:21 242:19 241:15,16,17 150:14 153:16  
**discussions** 48:10 **DNA** 155:20 156:23 157:3  
 53:13 66:3 72:2,22 **DOC** 20:17 21:6 74:8 163:11  
 88:23 115:2 171:8 76:4 171:15,17,21 175:4  
**dispersion** 30:12 **docket** 2:15 178:11  
**dispersive** 30:8 **Doctor** 11:12 **doses** 153:12 154:7  
**disruption** 155:6,11 **document** 141:18 **dosing** 154:6  
 166:9 160:6 219:23,25 **dots** 186:20,21  
**dissect** 179:7 222:12 **doubt** 6:8 20:4  
**dissipation** 229:3 **documentation** 183:1 24:21  
**dissolution** 12:16 **documented** 179:22 **Doucette** 21:21,22  
**dissolved** 181:14,16 182:9 23:24 24:11  
 21:7,10,15 183:16 184:2 35:25  
 25:11,15,22,25 **Documents** 160:5 36:2,7,10,12,25  
 27:4,18,22,23 28:5 **DOM** 74:8 90:18 92:9,11,14  
 38:7,9 65:1,5,6 **dominate** 64:3 127:1 103:18 105:19  
 67:11 70:14,17 **dominating** 96:13 108:22,23 115:1  
 75:4 **Don** 9:3 11:17 13:21 117:7 119:12,14  
**distance** 91:22 25:17 167:2 **Doucette...I...I**  
 185:15,16 192:7 **done** 14:1 29:9,13 108:13  
 194:4 198:3 211:20 42:11 45:23 55:7 **dovetails** 61:21  
**distances** 182:17 **downstream** 39:21

**dozen** 64:3 44:7, 8, 9, 10, 11, 13, 163:18, 19, 20  
**Dr** 2:17, 20 20 164:1, 2  
 3:14, 17, 18, 19 46:1, 5, 6, 22, 24 168:6, 8, 9, 11, 12, 13  
 4:4, 6, 7, 8, 9, 10, 11, 48:5, 7 49:5, 21 , 15, 16, 18  
 15, 16, 18 50:11, 13, 14, 16, 17, 171:6, 7, 11, 12, 13  
 5:10, 15, 16 6:12 19, 20, 22 58:10 172:1, 3 173:6  
 7:15, 20, 21, 22 65:20, 25 66:1 175:10, 22, 25  
 8:1, 4, 8, 13, 14, 16, 1 70:5, 7 176:1, 12, 13  
 7, 19, 23 71:3, 11, 23, 24, 25 177:13, 14  
 10:6, 8, 10, 11, 13, 14 72:1, 6, 18, 20, 21 178:4, 14, 15  
 , 17, 24 73:15, 17 179:1, 8, 11, 17, 19  
 11:1, 2, 4, 6, 12, 14, 1 77:3, 7, 18, 19 180:10, 12, 16, 18  
 5, 17, 21 78:7 81:22, 23, 24 187:10, 14 203:24  
 12:2, 5, 6, 8, 9, 11, 13 82:20, 22 83:5 204:5, 8, 12, 13, 14, 1  
 , 18 84:13, 22, 23 85:7 5, 16, 23, 24  
 13:10, 15, 16, 21, 25 86:2, 4, 14, 15 205:4, 6, 15  
 14:13, 17, 23 87:4, 6, 7, 9, 16, 17 206:11, 13, 20, 23, 24  
 15:2, 3, 4, 6, 7, 9, 10, 88:11, 20 207:3, 7, 14  
 12 16:24 89:10, 12 90:7, 9 208:1, 2, 17, 18  
 17:3, 11, 15, 19, 20, 2 92:7, 8, 9, 11, 13, 14 209:6, 9, 11, 15  
 2, 24 95:17, 18 210:4, 6, 25  
 18:1, 2, 5, 6, 11, 12 99:15, 19, 21, 22, 23, 211:1, 5, 12, 13, 16  
 20:4, 11, 12, 14 25 100:2 103:17 212:11  
 21:20, 22 104:2, 6, 7, 8, 20, 21, 213:8, 9, 14, 18, 20, 2  
 23:20, 24 22 1, 22  
 24:1, 11, 12, 14, 16, 1 105:7, 16, 18, 19 214:12, 15, 21  
 7, 18, 20 106:3, 4, 17, 20, 21, 2 215:5, 8, 18, 22  
 25:2, 6, 7, 8, 13, 14 2, 24 216:10, 13  
 26:4, 14, 15, 17, 25 107:3, 4, 5, 18, 21 217:6, 7, 8, 9, 10  
 27:1, 2, 3, 6, 9, 11, 15 108:7, 12, 22, 23 220:3, 16, 17  
 28:12, 14 110:19, 23, 24 223:13, 14, 15  
 29:12, 19, 20 113:14, 15, 16, 17 224:21 229:1, 18  
 30:1, 20, 21, 23 115:1, 22, 24 231:4, 5, 6  
 31:18, 20 116:7, 9 117:7 235:3, 4, 5  
 32:1, 6, 7, 17, 20, 21 118:7 119:11, 13, 14 238:1, 4, 5  
 33:3 121:13, 14 239:12, 13, 14, 20  
 34:3, 7, 8, 13, 19, 20 129:8, 9, 11, 16 240:5 241:11, 23  
 35:8, 10, 11, 12, 16, 1 130:8, 20, 21 131:13 242:4, 11, 15, 16, 18,  
 9, 20, 21, 24, 25 132:25 19 243:7  
 36:2, 5, 7, 8, 10, 11, 1 133:2, 3, 16, 19, 20, 2 **drainage** 230:16  
 2, 14, 15, 25 5 134:2, 5, 6, 12 **drainoff** 32:11  
 37:2, 4, 5, 8, 9, 10, 12 135:11, 12, 14 **dramatic** 166:15  
 38:3, 4, 13, 14, 17, 18 136:9, 20, 25 **draw** 17:12 162:14  
 , 21, 22, 24 39:2, 4, 7 137:1 138:9 163:12  
 40:2, 4, 11, 12 139:11, 23 **drawback** 150:8  
 41:1, 2, 5, 8, 9, 19 140:1, 6, 8 **dreary** 195:7 206:18  
 42:1, 6, 18, 23, 25 141:8, 9, 10, 11, 12 **dredge** 43:16  
 43:6 161:2, 3, 5 **drift** 19:6, 7 21:1



<b>either</b> 2:16 15:2 46:6 55:19 62:2 69:23 71:8 77:5 83:7 88:2 116:22 177:15 183:22 186:6 196:20 200:21 201:11 202:7 209:19 213:24 219:16 238:14	<b>emphasized</b> 5:10 <b>emphasizing</b> 110:6 <b>emphasis</b> 111:1 <b>empirical</b> 73:8 182:19 194:3,21 198:2 <b>employ</b> 198:11 <b>employed</b> 5:12 <b>encompasses</b> 49:7 <b>encountered</b> 216:15 <b>encourage</b> 67:9 68:7 218:23 <b>encouragement</b> 67:20 <b>encouraging</b> 218:22 <b>endpoint</b> 126:11 160:10 <b>endpoints</b> 150:17,19 160:13 176:16 218:19 <b>energy</b> 197:5 211:8 <b>engineered</b> 219:3 <b>engineers</b> 11:8 28:15 150:21 <b>England</b> 94:20 <b>enhance</b> 142:6 <b>enhancement</b> 22:3 <b>enjoyed</b> 137:2 <b>enormously</b> 20:6 <b>enter</b> 19:14 37:12 152:9 <b>entering</b> 38:23 <b>enters</b> 102:6 <b>entirely</b> 169:25 <b>entitled</b> 77:23 <b>entrained</b> 38:25 200:25 <b>entries</b> 38:19 <b>envelope</b> 19:8 <b>environment</b> 64:11 71:15 75:1 78:23 79:4 96:3,15 97:13 99:3 111:3,12 112:5 122:24 135:20 145:12 180:2 186:7 191:4 218:6 243:4	<b>environmental</b> 8:25 49:13 58:9 140:17 194:12 195:12 196:11 239:24 241:15 <b>enzyme</b> 111:16 121:10 <b>EPA</b> 2:15 3:11 4:19 5:21 6:12 62:6 72:6,9 117:2 130:18 139:21 150:25 160:6 208:13 219:21 230:8 <b>epi</b> 237:2 <b>epi-SUITE</b> 9:10 <b>EPM</b> 5:22 <b>equal</b> 17:17 69:6 <b>equally</b> 92:18 154:25 156:5 <b>equate</b> 166:20 <b>equation</b> 40:18 41:22 106:8 108:2 206:15 <b>equations</b> 30:1,2,18 45:13,16 46:7 57:4 107:16 108:3 122:13 146:14 213:5 <b>equilibrium</b> 103:4 <b>equilib...the</b> 9:24 <b>equilibrium</b> 10:2 65:9 71:14,15 78:18 80:4,15,16,19,22,2 3 103:7 105:21,23,24 106:15 171:3 234:10 <b>equivalent</b> 69:1 <b>ER</b> 142:19,22 146:1 150:15 160:12 <b>ER10</b> 146:7 <b>ERED</b> 150:22,24 <b>EROD</b> 170:14 <b>erode</b> 43:18
<b>elaborate</b> 48:18 207:14 <b>electron</b> 197:9 <b>elegant</b> 60:11 <b>elements</b> 62:24 <b>elevation</b> 182:3 <b>eleven</b> 149:23 <b>eliminate</b> 37:21 143:2 <b>eliminating</b> 34:10 <b>elimination</b> 52:13 54:6,15 55:18 56:23 58:15 64:10 68:2 69:19,20 73:21 <b>else</b> 4:3 76:23 103:25 166:23 170:19 <b>elsewhere</b> 84:2 134:1,3 <b>embarked</b> 224:17 <b>emerge</b> 237:1 <b>emerging</b> 62:8 219:10 <b>emission</b> 185:24 186:6 201:21 202:1 203:11 <b>emissions</b> 188:19 200:13 201:17,18 202:6,10 203:16,20 204:19 206:25 210:21 <b>emitted</b> 210:11 <b>emphasis</b> 5:8 30:24 92:17 <b>emphasize</b> 5:17,22 97:18 167:23		

**eroding** 44:5  
**erosion** 31:14  
 41:5,6,8,20 42:7,9  
 44:19 45:1,8  
 226:9,10  
**error** 68:18  
**errors** 17:8  
**ES&T** 186:13  
 189:12 198:1  
**especially** 25:21  
 28:5,23 30:11 69:2  
 80:22 132:22  
 134:19 143:12  
 150:2 155:4  
 157:2 163:23  
 164:14 172:15  
 176:5 184:13 185:3  
 232:3 235:15  
**essence** 16:12 36:22  
**essential** 126:20  
 212:16  
**essentially** 11:5  
 28:4 30:5 51:3  
 78:24 113:8 130:24  
 194:22 229:11  
**established** 127:18  
**esteemed** 119:10  
**estimate** 26:11  
 36:18 60:21  
 61:23 68:3 131:1  
 134:25 148:19  
 178:8 201:18  
 204:24 225:12  
**estimated** 26:9  
 202:3  
**estimates** 61:20  
 89:17 194:3  
 196:9 200:12  
 201:16  
**estimating** 175:15  
 221:25  
**estuaries**  
 32:8,11,14 39:9  
 40:16 41:12  
 62:18 211:15,17  
 213:7  
**estuarine** 213:1  
**estuary** 7:25  
 29:17 31:22,24  
 32:4 33:7 137:22  
 200:21 211:19  
**et** 31:23 58:14 80:6  
 133:10 136:10  
 182:22 186:12  
 189:12 190:24  
 211:10  
**ethanol** 166:6,10  
**Europe** 148:22  
 181:22 183:4  
**European** 181:7  
**Europeans** 26:21  
**evaluate** 61:11  
 133:14 167:11  
 207:19  
**evaluate....the**  
 208:23  
**evaluated** 167:16  
 211:24  
**evaluating** 210:7  
**evaluation** 209:17  
 219:19  
**evaluations** 145:11  
**evening** 242:13  
 244:3  
**event** 38:6 144:20  
 191:21,22 192:1  
 209:20,21 230:22  
**events** 191:22  
 230:25  
**everybody** 46:11  
 66:15 86:9 88:21  
 132:12 139:12  
 204:10 205:25  
 209:19 242:13,14  
 243:12 244:4  
**everyone**  
 2:5,8,13,21 86:9  
 88:12 215:19  
 243:16  
**everyone's** 139:21  
**everything** 20:1  
 39:15 46:15  
 80:21 111:14 164:4  
 166:4 179:10  
 205:19 243:16  
**evidence** 82:4  
 182:19  
**evident** 6:24  
**evolution** 234:9  
**evolutionary** 236:18  
**evolved** 107:6  
**exact** 177:6  
**exactly** 10:17  
 19:1 168:23  
**EXAM** 214:6  
**examine** 224:17  
**example** 29:22  
 44:1 49:15 53:1  
 58:8 59:21,24 62:6  
 63:19 68:10  
 78:14,20 79:12  
 80:6 81:1,18 85:21  
 101:21 104:2 105:9  
 106:9 111:19  
 112:23 113:5 116:1  
 118:11,22 119:1  
 123:2 124:1 125:25  
 127:5,23 128:10  
 130:15 131:16,18  
 132:7 144:14  
 145:19 147:5 149:9  
 152:24 153:22  
 160:6 162:5 165:17  
 166:7,11 168:21  
 169:1,6,16  
 170:6,13 171:24  
 177:2 181:15  
 182:1,20 187:2  
 190:13 197:22  
 198:1 210:13,17  
 213:12 219:1  
 229:14 236:25  
 238:24 239:14  
**examples** 62:4  
 100:14 104:1  
 122:24 149:20  
 182:11 236:5  
 238:15  
**EXAMS** 9:7 11:19  
 12:1 18:24 30:25  
 31:22 33:20

37:8,9,10 49:14	<b>experimental</b> 199:19	175:4 180:5
85:11 226:4	<b>experimentally</b>	194:1 200:7,9
<b>EXAMS...right...</b>	63:11,17	207:6,25 223:19,22
<b>dissolved</b> 37:13	<b>experimentation</b>	224:4
<b>exceed</b> 20:20 24:7	14:1	227:6,10,19
<b>exceed...the</b> 24:6	<b>experiments</b>	230:3 241:17
<b>exceedances</b> 24:13	15:14,18 20:7	<b>exposures</b> 60:17
<b>exceeded</b> 22:24	24:14 27:17	74:4 87:6 96:11
<b>exceeding</b> 23:7	42:12 113:22	126:21 127:1 128:5
56:17	147:21 150:10	141:6 152:1,2,3
<b>exceedingly</b> 96:11	154:20 157:8	164:13,14 170:3
<b>excellent</b> 70:8	203:4,8	<b>exposure's</b> 159:12
84:20 204:14	<b>expert</b> 177:7	<b>extend</b> 97:1,12
<b>exception</b> 123:5	<b>expertise</b> 43:3	203:18,20
<b>exceptions</b> 105:12	126:18	<b>extended</b> 210:1
<b>excess</b> 157:3	<b>explain</b> 9:1 18:17	<b>extension</b> 214:2
<b>exchange</b> 122:8	30:21 144:6 222:15	225:3
185:3	<b>explicitly</b> 51:17	<b>extensive</b> 87:24
<b>exciting</b> 222:5,7	232:21 235:12	133:22
<b>excreted</b> 169:4	<b>explore</b> 74:19 136:5	<b>extensively</b> 47:3
<b>excute...of</b> 89:17	236:23	207:20 235:23
<b>exercise</b> 189:21	<b>explored</b> 33:7,8	<b>extent</b> 6:10 50:8
214:5	<b>exploring</b> 81:15	92:2 101:9,16
<b>exhaustive</b> 238:17	207:5	116:3,15 134:7
<b>exhibit</b> 147:18	<b>explosion</b> 197:24	172:23 216:24
154:15	<b>exponentially</b>	231:8 234:7,20,25
<b>exhibits</b> 149:21	102:18	<b>extra</b> 20:25 25:4
<b>exist</b> 103:13 123:25	<b>exposed</b> 16:19	69:14,15 71:22
129:23 232:17	111:17,21 112:4	<b>extract</b> 194:3
<b>existing</b> 6:13 11:18	143:20 193:23	<b>extracted</b> 194:17
52:3 83:7 85:18	<b>exposure</b> 33:13 40:3	<b>extraordinarily</b>
90:5 122:2	47:5,8,12 49:11	117:9
172:12,22 225:11	60:21 71:14	<b>extrapolate</b>
<b>exists</b> 45:21	74:13 75:19	112:24 173:21
<b>expand</b> 95:21	85:12 89:18	175:18,21
<b>expand...I</b> 95:21	93:6,23 98:19	<b>extrapolating</b> 63:19
<b>expanded</b> 237:13	111:25 113:11	<b>extrapolation</b> 18:16
<b>expands</b> 162:12	123:9,24 126:8	24:9 175:24
<b>expect</b> 26:6	127:6 128:7 129:14	<b>extremely</b> 28:16
138:19 139:3	133:7,18,23	78:23 132:14
148:12 188:12	140:9,11,12,15	153:25
242:5	141:1 142:19,24,25	
<b>expected</b> 80:14	151:9 152:5	F
<b>expended</b> 224:24	154:9 158:7 161:12	<b>face</b> 54:19
<b>experiment</b> 15:20	163:12 164:17	<b>faced</b> 54:10
24:25 71:10	169:17,21	<b>fact</b> 5:23 9:6 13:12
	170:9,10,16 171:23	22:21 26:1 59:6

67:22 68:4 78:7  
80:1 100:15,20  
101:4 103:5,15  
105:12 123:10  
126:25 134:2 165:7  
168:22 211:21  
213:5 219:21  
221:15 241:2  
**fact...or** 78:9  
**factor** 55:6,16  
56:3,11 69:13  
102:18,21 117:11  
153:18 176:4 202:1  
210:3,5 232:23  
**factors** 19:4 47:4  
51:6 55:5,14  
56:7 68:4 69:5  
70:21 89:25  
93:13 100:16  
108:20 151:7  
161:14,15 210:2  
**factors...I** 20:15  
**failing** 8:9  
**fair** 21:24 57:20  
71:16 122:7  
**fairly** 23:15  
34:17 43:13  
45:23 73:11 74:4  
75:24 86:11 94:2  
100:19 107:5,6  
112:22 122:3  
138:22 169:15  
170:17 178:16  
182:4 188:8 212:20  
**fall** 8:10 77:14  
79:14 102:21 166:1  
212:17  
**falls** 79:20  
105:10 133:4  
**familiar** 43:8  
131:18  
**farm** 7:9 32:13  
82:14 84:6  
207:2,12  
**farther** 181:19  
183:11  
**Faruque** 3:14 214:12  
**fashion** 129:24  
**fast** 18:14 129:17  
**faster** 191:17  
222:22  
**fat** 161:19  
171:18,22 239:5  
**fate** 29:2 31:24  
32:16 83:2 93:8  
96:23 98:18  
122:14,15 123:3  
129:3 239:24  
241:15  
**fault** 9:1  
**favorably** 187:16  
**FDA** 241:10  
**fear** 43:17 165:22  
**Federal** 2:7  
**feedback** 97:10  
125:10 175:7  
**feeders** 134:15  
**feeding** 58:22  
59:3 71:5 86:20  
94:7 127:4  
134:13 171:15  
**feel** 84:15 119:15  
136:21 143:19,23  
187:11 243:1  
**feeling** 141:11  
**feet** 240:22  
**fell** 102:18  
**felt** 171:9 196:3  
**female** 76:15  
**females** 161:21  
**feminization** 236:11  
**fewer** 148:2,6  
183:18  
**field** 18:17,23  
19:1,5 20:19 33:21  
41:8,9 45:2  
47:10 51:9,10 81:2  
83:23 84:6  
91:10,11  
99:11,12 125:11  
129:4 133:24  
137:10 143:13,22  
158:9 171:21 180:4  
200:6 207:2  
208:4,9,14 214:3  
219:11 225:17  
227:22  
228:1,9,17,20,25  
229:3,5,6  
230:9,11,17,20,23  
231:25 240:10  
**field-based** 72:4,14  
**fields** 37:16  
203:5 213:23  
214:1,2 223:24  
224:2,5,15  
**FIFRA** 2:1,18,22  
139:13  
**fifteen** 166:5  
215:15 234:13  
**fifth** 146:9 147:1,6  
148:16  
**fifty** 142:22 147:23  
155:13 170:25  
181:8 206:16  
214:19,25  
**figment** 101:4  
**figuratively** 168:15  
**figure** 8:9 221:9  
**figures** 162:16  
**figuring** 191:19  
**fill** 42:4  
**filter** 27:8,10,21  
28:3 195:20,22  
**filter...once** 28:3  
**filtration** 21:11  
25:16  
**final** 127:1 220:3  
222:18  
**finalized** 32:3  
**finally** 199:23  
**finding** 54:19  
149:11 205:9  
217:24  
**fine** 24:8  
29:10,13 30:6 31:8  
57:4 76:6 152:18  
157:14 158:2  
212:12  
**finely** 158:23  
**fines** 76:5

**finesse** 138:7  
**finish** 220:17  
**finished** 215:12  
**Finner** 189:12,15  
 193:11  
**first** 3:11 21:23  
 34:4 35:5 40:13  
 54:3 57:2 66:7  
 80:2 85:16,18  
 88:22 91:1 92:5,10  
 99:4,6,21,22  
 106:16 108:15,21  
 113:1 117:24  
 119:12 123:2  
 124:11 134:12  
 141:14 142:8  
 154:12 160:23  
 161:3 168:1,2  
 176:14 181:2,10  
 182:12 192:18  
 198:10 202:16  
 213:21 216:2  
 217:18 218:24  
 219:11 220:15  
 221:15 223:14,20  
 226:15 231:7  
 242:14  
**fish** 32:11 50:5  
 53:20 55:25 56:3  
 57:13,14,18  
 58:23 60:10,20  
 74:12 77:13  
 79:14 80:18  
 93:16 94:9,11  
 102:23 115:20  
 121:9 134:16,21  
 153:23 154:3  
 157:12,14  
 158:19,20,23  
 160:5,7 163:14  
 165:1,7 169:4,19  
 171:16,17 179:6  
 237:1,7  
**fish-eating** 49:24  
**fitness** 159:1  
**fits** 74:18 110:25  
 122:14 209:4  
**five** 31:3 51:3 72:7  
 142:13 147:2,23  
 148:17 162:19  
 166:13 179:5  
 193:13 214:19,25  
 224:16 234:14  
**fix** 9:7 22:17,20  
 23:1,8  
**fixed** 31:13 34:14  
 77:10 82:14  
 190:22,23  
 192:9,20,21  
**fixing** 67:13  
**flag** 206:7  
**flat** 17:1 212:17  
**flexibility** 118:4  
**flip** 181:12  
**floating** 21:2  
**flow** 39:15,18  
 41:11,12,13,15  
 45:15,19 116:2  
 191:15 230:16,21  
**flowing** 7:12 33:8  
 39:9,12,17,22,25  
 40:9  
**flows** 212:23 228:10  
**fluctuate** 41:13  
**fluctuating** 85:12  
**fluctuations** 86:1  
**fluid** 38:20  
 147:12 149:15  
**fluorochemicals**  
 184:11  
**flux** 185:23,25  
 202:21 203:13  
 204:2,25 205:1  
**fluxes** 203:5,11  
**flyers** 188:7  
**FOC** 9:12  
**focus** 5:8,11  
 11:24 124:5,6  
 130:23 134:4 163:9  
**focused** 11:22 51:20  
 109:8 123:4 131:11  
**focusing** 124:21  
 163:9 166:25  
 168:19  
**foliage** 117:14  
**foliar** 201:8  
**folks** 72:7 167:24  
 241:14,18  
**follow-up** 27:5 36:2  
 39:5 88:14  
**food** 49:20 50:4  
 51:11 53:20  
 55:10,11 57:1,10  
 58:1 59:6,7,25  
 60:12 61:20  
 80:11,14,17  
 82:12,14 84:25  
 85:9 87:25  
 89:15,21,23,24  
 90:2,5 101:24  
 102:3 112:3  
 118:5,13,24  
 119:6 126:9  
 127:3,10 128:7,8  
 130:16 132:16  
 136:17  
**for...for** 14:7  
 52:12 56:19  
 63:18 64:12  
 72:16 96:14  
 109:5,12 110:1  
 115:10,20 139:9  
**for...from** 134:16  
**for...similar**  
 109:15  
**forage** 155:21  
**force** 139:3  
**forced** 195:20  
**foreign** 132:13  
**forest** 126:2  
 195:21,22  
**forever** 229:11  
**forget** 129:9  
**forgotten** 123:17  
**form** 6:9 10:22  
**formalized** 27:12  
**formally** 104:15  
**formed** 170:23  
 240:10  
**former** 62:4  
**forms** 74:8

**formula** 42:7,8 169:13 232:9 144:10 145:24  
 242:8 **fruit** 115:14 125:13 147:15 150:11  
**formulated** **fruits** 117:14 155:1,15 156:11,18  
 19:6,19,21 **FSB** 172:16 160:15 175:12  
**formulating** 42:5 **fugacity** 98:5 103:8 190:17 196:4 197:2  
**formulation** 7:7 185:1,13,14 204:7 210:23  
 22:9 66:15 91:3 189:9 192:5  
 201:7 **generalizations**  
**formulations** 98:13 **full** 124:14 193:24 115:10 151:5  
**forth** 147:12 **fully** 122:22 **generalize** 203:20  
**fortunate** 165:18 **fully-coupled** 98:11 **generally** 3:10  
**forty** 149:22 **fumaGEN** 201:3 5:3 22:11 94:5  
**forward** 18:15 46:17 **fumigant** 213:25 116:5 118:5 203:10  
 52:15 88:25 116:17 **fumigants** 204:3,6 211:11 214:17  
 178:21 218:10 **fun** 188:3 217:24  
 219:15 220:2,11 **function** 35:3,18 **generally...in** 6:2  
 222:6,11 234:10,17 36:19 42:7 44:16 **generate** 120:14  
**forward...and** 51:16 45:18 58:24 **generated** 150:12  
**forwards** 26:24 113:9 147:7 195:23 **generating** 120:3  
**foundation** 95:13 205:1 **generic** 50:4 58:1  
**fraction** 13:8 21:15 **fundamentally** 118:23 202:4  
 25:10,11 26:23 57:3 63:8 213:10  
 142:21 **funded** 32:1 **geographical** 50:6  
**frame** 124:3 **future** 30:10 84:8 **geography** 195:13  
 137:10 218:11 143:3 157:18,21 **Geological** 32:2  
 224:13 160:9 196:11 198:5 **George** 150:22  
**framed** 200:4 **futuristic** 75:9,21 **Georgia** 225:22  
**frames** 97:16 218:12 **fuzzy** 107:15 **geriatric** 167:14  
**framework** 32:24 

---

---

**gets** 107:15 116:4  
 160:22 180:5 **G** 130:2 173:16  
**frameworks** 232:18 **gain** 219:12 223:4 174:18 176:21  
**Francisco** 213:6 **gamut** 221:2 **getting** 6:21  
**Frank** 6:12 57:12,21 **Gan** 25:2,7,13,14 21:18 41:16  
 186:1 193:22 180:21 205:5,6 74:7,24 86:16 88:4  
**free** 197:5 211:8 **gap** 173:2 90:10 96:17 108:25  
**freely** 21:7,14 **GARBER** 136:23 120:21 139:22  
 25:11,15,22,24 **garden** 114:22 143:8 176:14 182:5  
**fresh** 187:24 192:14 125:21 193:9 202:10  
 237:9 **gas** 23:24 196:17,19 207:15  
**fresheners** 240:23 197:11 199:8 **gigantic** 116:3  
**Friday** 33:11 **gee** 181:9 **gill** 52:13 54:15  
**frightening** 220:23 **geez** 232:8 75:17 152:9  
**from...from** 5:18 **gender** 76:14,21 **GIS** 203:19  
 58:3 60:19 94:16 **general** 6:2 40:20 **given** 6:5 50:6  
 106:9 54:7 89:16 94:13 72:14 74:6  
**front** 66:14 109:13 112:22 99:7,8 124:17  
 125:7 143:16 146:6

148:9 156:20	235:17	161:7 166:18 167:4
168:22 175:16	<b>gray</b> 61:14	175:13,20 177:7
<b>gives</b> 44:16 51:25	<b>great</b> 77:20 86:8,20	204:9 223:8 229:18
52:14,15 143:19	87:10 111:5 125:18	<b>guidance</b> 21:16
216:2 220:10	137:7 146:16	53:15 91:7 219:23
<b>Glacier</b> 182:10	150:25 153:22	<b>guide</b> 173:4
<b>glad</b> 4:10,11 172:16	156:11 164:2	<b>guideline</b> 67:3
<b>Glazier</b> 113:6	165:17 166:7,11	146:13 178:21
<b>global</b> 99:9,10	181:18 182:10,24	<b>guidelines</b> 42:12
109:1 125:4 182:23	204:6 212:7 213:12	145:17 146:17
186:4,7	<b>greater</b> 49:6,12	174:4,11 220:1
190:13,17,19	93:25	241:25 242:6
197:21,22	94:10,14,16,22	<b>gut</b> 79:16,17,20
<b>globe</b> 192:11,12	137:10 198:14,15	101:11 103:8 152:9
<b>goal</b> 7:13	<b>greatly</b> 212:9	<b>guys</b> 8:24 82:17
<b>Gobas</b> 6:12 53:17	<b>green</b> 188:1	93:7 166:21 205:19
57:3,21 58:10,25	<b>ground</b> 106:1 117:19	220:23 222:7,18
60:5 62:9 73:6	192:14 212:15	231:10,17
76:21 77:8	229:4	<b>gym</b> 240:20
100:4,24 101:20	<b>group</b> 74:2 90:15	
102:2 104:2 118:12	92:20 94:18,19	H
220:3	115:11 118:12	<b>habitat</b> 123:11
<b>God</b> 199:21	124:20 133:12	131:7
<b>goldfish</b> 86:10	171:8,11 184:19	<b>had...and</b> 137:16
<b>gonad</b> 165:19 177:2	186:1,19 189:5,7	<b>half</b> 33:21,22,24
<b>gonadal</b> 176:17	191:7 193:10,22	37:17 38:4,6,8
<b>gone</b> 43:3 60:9,10	206:12 211:6	42:21 64:3
65:18 96:24 116:14	216:3,5	184:16,20,21
221:2	<b>group...and</b> 62:9	192:19 198:14
<b>good...another</b> 52:2	<b>groups</b> 108:5 120:16	206:17 215:3
<b>gospel</b> 102:12	140:11	229:11 243:25
<b>Goss's</b> 211:5	<b>grow</b> 59:4 212:22	<b>half-life</b> 28:24,25
<b>gotten</b> 74:5	<b>growing</b> 116:4 124:6	<b>hammer</b> 165:10
<b>govern</b> 138:12	184:13	<b>hampered</b> 172:6
<b>governs</b> 34:21	<b>growth</b> 55:25 56:5	<b>hand</b> 15:21 16:11
<b>gradation</b> 143:9	57:14 58:23 59:1	42:11 131:12
<b>gradients</b> 194:2,18	67:6 144:23,24	181:23 196:13
<b>gram</b> 155:13 171:17	150:18 153:25	<b>handle</b> 40:20 130:24
<b>grammar</b> 65:8	160:11 161:18	<b>Hands</b> 42:25
<b>Grange</b> 185:9	176:6	<b>happen</b> 35:17 123:11
<b>Grangian</b> 202:8	<b>guess</b> 10:17,21	128:25 144:15
<b>granules</b> 133:9,15	12:13 17:13	177:25 184:25
<b>grasses</b> 114:20	22:25 30:6 36:3	<b>happened</b> 3:21
<b>grass-hopping</b>	58:5 73:10 84:14	241:21
188:23	108:10 119:15	<b>happens</b> 9:22
<b>gratification</b>	121:3 137:17	14:22 43:21
	138:15 139:12	84:12 97:15 100:25

105:10 121:10	<b>heard</b> 19:3 32:23	210:25 211:12
135:7 202:11 208:9	218:17	213:8,14,20
238:21	<b>heavily</b> 179:23	215:8,18 217:6
<b>happy</b> 241:13	219:16	220:16 223:13
<b>hard</b> 86:7 128:20	<b>hector</b> 227:21,23	231:4 235:3
129:17 141:23	228:9	238:1 239:12,20
149:13 151:4	<b>Heeringa</b> 2:18,20	240:5 241:23
164:21 177:1	4:4,7,10,16 7:20	242:11 243:7
191:19	8:8,16,19 12:11	<b>height</b> 44:16
<b>hard-learned</b> 123:16	15:10 18:11	<b>held</b> 151:7
<b>has...has</b> 62:6	20:12 21:20	<b>helicopter</b> 207:10
<b>hate</b> 232:7	24:16,18 25:2,13	<b>hell</b> 16:7
<b>hats</b> 137:1	26:15,25 27:2	<b>help</b> 83:10 91:24
<b>have...and</b> 84:22	28:12 29:19	104:18 136:4
<b>have...basically</b>	30:20 31:18	224:12 225:8
101:10	32:6,17 34:13	231:21 241:17
<b>have...I</b> 33:17	35:25 37:4 39:4	<b>helpful</b> 4:16 129:8
<b>have...or</b> 36:3	40:2,11 42:18,25	<b>helps</b> 143:7 222:15
<b>have...that</b> 186:18	44:7,11 46:5	<b>hemic</b> 211:10
<b>have...what</b> 29:12	48:5	<b>hen</b> 168:17
<b>haven't</b> 32:3	50:11,14,17,20	<b>Henney</b> 87:10
44:11 74:5 85:13	65:20 70:5 71:3,23	<b>Henry's</b> 188:17
96:24 130:12 208:3	72:18 77:3,18	<b>hepatic</b> 74:15
215:11 241:5	81:22 84:13	<b>hepatopancreas</b>
<b>having</b> 10:23	86:2,14 87:4,16	177:2
91:23 116:19	88:11,20 90:7	<b>heptachloro</b> 101:9
143:18 150:10	92:7,9,13 95:17	<b>herbivore</b> 117:23
175:2 176:2	99:15,21,25	<b>herbivores</b>
178:7 191:19	104:6,20 105:16	117:12,13,20
227:13 231:2	106:3 108:22	<b>Here's</b> 202:8
<b>hazard</b> 88:1 148:16	110:23 113:14	<b>Hermans</b> 169:14
<b>hazards</b> 123:23,24	115:22 116:7	<b>heron</b> 86:8,20
<b>HC05</b> 148:15	119:11 121:13	<b>He's</b> 11:8
<b>HCH</b> 100:19 105:9	129:8 130:20	<b>heterogenous</b> 143:17
<b>HCHs</b> 182:21	132:25 133:16,20	<b>Hetrick</b>
<b>head</b> 22:2 85:13	134:2 135:11	10:6,10,13,17
108:25 135:14	136:20,25 138:9	11:1,4,12,15,21
<b>headache</b> 49:1	139:11 141:8 161:2	12:5,8,13 13:10,16
<b>headed</b> 33:9	163:18 164:1	14:23 15:3,6 16:24
<b>heading</b> 33:18	168:6,11,13	17:11,19,22 18:1,5
241:11	171:6 172:1	36:5,8,11,14
<b>heads</b> 181:3	173:6 175:22	37:2 204:23,24
<b>health</b> 126:23	176:12 177:13	207:3,14 214:18
135:23 167:13,24	178:14 179:11	<b>hexachloro</b> 101:9
241:16	180:10 187:10	<b>hexachlorobenzene</b>
<b>hear</b> 4:25 33:1	203:24 204:8,15,23	16:22
	205:4 206:11,23	
	208:1,17 209:6	

<b>hexachlorocyclohexanes</b> 184:3	137:11 178:24 217:13	<b>hugely</b> 165:6
<b>HHS</b> 241:10	<b>highest</b> 123:9 132:13	<b>human</b> 126:21,23,25 128:6,22,23 132:16 135:15,23 167:13,23
<b>Hi</b> 70:7	<b>highlight</b> 70:2 72:23 164:5 221:15	<b>humans</b> 126:25 135:21 136:12 235:16
<b>Hickie</b> 13:25 14:17 15:2 32:1 48:6,7 50:13,16,19,22 65:21 72:1,21 73:15 77:6,7 84:24 85:7 86:14,15 90:7,9 92:8 99:15,19,22 104:20,21 113:15 116:7,9 119:13 134:13 141:11 161:3,5 163:18 177:13,14 178:4 209:9,11 210:25 211:1	<b>highlights</b> 104:14 <b>highly</b> 35:12 75:13 145:14 149:7 176:17 177:4 178:22	<b>hundred</b> 67:23 154:18 181:19 184:22 192:10 202:5 214:20 215:1
<b>Hickie's</b> 66:2 179:1	<b>hindsight</b> 90:13	<b>hundreds</b> 208:5,13
<b>hide</b> 134:21	<b>history</b> 59:21 60:3 62:25 124:22 235:20	<b>hybrid</b> 73:5
<b>high</b> 6:17 7:11 9:22 21:3 22:5,6,10 28:5 29:15 41:14 58:6 73:11 76:25 79:14 80:7,23 100:17,20,21,25 102:21 103:1 105:11 107:24 110:7 122:1,2 125:7 126:6 132:4 153:19 160:22 175:3,4 182:2 188:11,17 210:14	<b>hit</b> 22:2 70:15 164:20,21 212:17 217:21	<b>hydrocarbons</b> 149:9 171:15
<b>high...high</b> 16:20	<b>hockey</b> 9:8,9 10:3,4 13:19,23 14:2,7,20 16:25 17:6 22:15 23:9,10,20 24:21 28:20	<b>hydrogen</b> 197:9
<b>high...in</b> 30:4	<b>hold</b> 3:3	<b>hydrologist</b> 28:17
<b>high/low</b> 74:20	<b>holistic</b> 52:1	<b>hydrophobic...</b> <b>hydrophobic</b> 34:9
<b>high-end</b> 6:3 89:17	<b>home</b> 33:11 86:17,25 87:3,4,14 119:8 220:21	<b>hydrophobic</b> 15:16 16:9,20 34:7,8,11 35:12,13 39:23 54:22 55:6 57:6 94:10,15 95:3 110:3 113:25 114:14 121:1 152:11 160:18 178:23 197:6
<b>higher</b> 9:25 15:23 16:12 20:19 36:23,24 61:9 80:13 100:17 101:11 103:1 113:20 127:21 132:1 134:7,14	<b>hope</b> 46:14	<b>hydrophobicities</b> 110:14
	<b>hopefully</b> 179:12	<b>hydrophobicity</b> 155:2 238:14
	<b>hopeless</b> 130:2	<b>hydrophotic</b> 23:15
	<b>hoping</b> 198:4 242:4	<b>hydrosorbic</b> 153:2
	<b>hoppers</b> 188:7,14,16,22	<b>hydroxy</b> 131:19
	<b>horizon</b> 197:3	<b>hypoth</b> 167:1
	<b>hormesis</b> 158:15	<b>hypothesis</b> 73:23 167:5
	<b>hormone</b> 238:25	<b>hypothetical</b> 189:16,17
	<b>hour</b> 139:8 243:25	
	<b>hours</b> 42:21 43:4 154:18 243:21	
	<b>house</b> 207:9	
	<b>hovering</b> 61:15	
	<b>huge</b> 142:10 143:14 145:8 153:17 154:5 159:23 164:15 212:6 239:19	
		I
		<b>I'm</b> 240:5
		<b>I...and</b> 110:5,20
		<b>I...aren't</b> 51:7

**I...each** 138:12 55:19,21 61:22 92:21,22 99:25  
**I...I** 7:22 13:22,23 104:12 119:21 100:7 101:3,19  
 19:3 28:14 30:23 144:1,3 223:6 103:11 109:14  
 32:7,12,13 37:5 **ideally** 14:13 110:15 114:2  
 40:13 51:15 **ideas** 135:13 221:13 118:17 119:15,20  
 57:2,11,20 61:14 **identified** 9:12 121:2,14,20 122:21  
 64:19 72:1,3 122:18 131:2 125:22,24 126:23  
 82:3 85:10 90:15 183:12 216:19,25 127:25 131:18  
 91:5 92:15 95:18 217:13 225:8 137:18 141:23  
 98:10 100:1,3 231:10 238:19 155:7 156:24 157:9  
 108:18 114:18 **identify** 90:1 159:3 162:5 164:21  
 116:10,14 117:5 184:17 227:11 165:25 166:21,24  
 119:17 121:3,4 **identifying** 168:11 169:20  
 133:3 139:2 217:22 231:8 172:4 174:18 175:6  
**I...I...I** 85:3 **if...if** 18:2 179:1 187:7,8  
 118:25 32:12 52:15 191:19 198:4 204:9  
**I...I'm** 126:17 55:21 61:11 206:1,25 207:15  
**I...in** 90:13 84:15 87:20 115:12 208:10,11 209:3  
**I...it...it...** 118:2 121:2 123:10 211:13 212:13  
**it's** 86:24 133:6 218:13 224:10  
**I...of** 8:23 **If...if...and** 59:18 226:1 227:16  
**I...the** 40:13 **ignore** 213:23 228:2,8,12,17  
**I...you** 115:17 **ignoring** 97:19 229:18,24 231:18  
**i.e** 124:24 **I'll** 3:2 66:12 68:7 **I'm...I'm** 17:11  
**ice** 183:13 70:9 89:7 90:16,17 **image** 45:4  
**I'd** 5:2 13:25 15:12 95:21 97:13 119:17 **image** 118:19  
 21:20 23:1,18 25:3 121:3,16,22 122:24 **imagining** 137:21  
 27:15 32:20 136:20 141:10 **imitate** 44:3  
 42:16 48:9 54:8,18 144:5 147:16 **immediate** 46:14  
 63:15 65:9,23 151:20 168:17 236:10  
 72:20 75:13 171:12 180:16 **immediately** 23:6  
 78:19 79:11 185:13 213:16 30:10 226:24  
 80:5,25 84:14 215:13 220:17 228:13  
 88:11,16 90:10 223:11 231:6 **immobile** 13:7  
 97:1,12 100:9 237:15,24 242:15 **immuno** 157:5  
 102:14 103:14 **I'll...I'll** 122:25 **immuno-compromise**  
 104:21 109:15 **illustrated** 48:4 158:11  
 113:15 119:9 **illustration** 242:22 **impact** 21:25  
 129:11 139:11 **I'm** 4:10,13 6:18 46:13 76:16  
 158:14 161:9 163:3 8:4,8 9:1 10:1 82:23 125:4  
 169:22 176:24 11:25 13:12,19 210:2,3,4 224:18  
 177:14 213:14,21 24:12,17 25:19 229:16 235:18  
 215:2 218:9,22 37:5 40:17,19 **impacts** 32:13 237:6  
 226:7 233:9 41:21 42:18,19 **implciations** 66:17  
 235:5 242:14 44:1 46:9 48:12 **implement** 30:3 67:4  
**idea** 22:16 29:18 53:24 62:13,16 **implementation**  
 42:12 52:9 65:8 67:17 87:20 82:16 226:3

<b>implemented</b> 33:9	199:4	<b>increase</b> 55:11
<b>implementing</b> 224:18	<b>improving</b> 30:25	161:19 205:11
<b>implication</b> 231:15	31:1 220:5	<b>increased</b> 16:1
<b>implications</b>	<b>in...based</b> 107:22	55:24 102:20
34:16 233:2	<b>in...birds</b> 102:16	149:24
<b>implied</b> 191:18	<b>in...in</b> 19:9,10	<b>increasing</b> 187:18
200:10	22:2 49:8	206:4,7
<b>import</b> 44:17	50:4,10 52:1 55:11	<b>indeed</b> 56:18 202:19
<b>importance</b> 71:13	57:4,5 59:14 62:10	<b>independent</b> 17:22
102:7 111:6	66:22 70:12	28:8 147:16
<b>important</b>	71:10 72:8 78:20	<b>indicated</b> 4:12 39:6
28:10,16,20,21,23	91:3,6 94:20	97:24 102:8 166:12
32:8 40:14 41:3	96:6 121:9 136:4	<b>indicates</b> 80:3
44:25 46:15	<b>in...they</b> 62:20	<b>indication</b> 20:2
49:16 53:14 54:6	<b>in...within</b> 80:24	186:22 195:11
55:9 56:1 57:23	<b>inadequate</b> 48:17	198:7
61:18 70:19	<b>include</b> 31:8	<b>indications</b> 96:22
71:19,20 74:14	49:10 71:9 86:12	<b>indicative</b> 87:13
76:13 85:2 87:1	125:9 126:21,24	<b>indicator</b> 87:15
90:2 91:2,14,16	180:24 181:1	96:21
92:16 95:20	213:11 225:19	<b>indicators</b> 95:20
96:14,16,21	<b>included</b> 56:16	98:9
97:3,10,23 98:10	126:12 195:19	<b>indices</b> 45:4
100:6 109:22,24	199:2 205:3 218:20	<b>indirect</b> 131:6
110:1,2 112:8	242:21	<b>individual</b> 81:11
117:11 118:4	<b>includes</b> 92:1	97:4 117:22 146:19
120:22 121:8	136:14 241:14	161:10 162:2,3
124:9,19,23	<b>including</b> 20:8,9	212:21
125:8 127:8,9	130:19 196:16	<b>individuals</b> 3:2
129:17 139:4	242:1	<b>indoor</b> 97:12
140:12 142:23	<b>inconsistencies</b>	<b>induction</b> 161:23
144:20 147:20	168:23	<b>industry</b> 241:1
150:20 152:16,21	<b>incorporate</b> 6:9	<b>inefficient</b> 79:18
160:8 164:23 165:6	60:3 61:3 67:6,8	<b>infancy</b> 200:1
188:13 191:1 197:8	75:18 104:14	<b>inflection</b> 73:20
201:2 206:14	140:15 143:1	<b>influence</b> 19:5
212:2,15,19 219:17	174:14 217:3	49:17
221:16 232:23	220:19 233:24	<b>information</b>
238:6,7	234:1 240:15	6:2,25 26:5,8
<b>impossible</b> 213:3	<b>incorporated</b>	32:19,24,25
<b>impression</b> 134:3	49:13 58:10	51:20 55:7,17,24
<b>improve</b> 45:4 120:12	72:10 76:20 98:3	56:2,8 60:19 69:12
196:10 198:6	<b>incorporates</b> 164:13	74:24 76:7 120:5
202:23 203:14	<b>incorporating</b>	121:12 125:17
<b>improved</b> 195:25	5:19 47:11 61:19	136:16 139:5 142:6
196:1 199:24	83:8 140:9 221:9	144:5 149:24
<b>improvements</b> 5:9	<b>incorporation</b> 205:2	150:4,7,16

151:1,15 175:2	<b>instrumental</b> 165:2	<b>interval</b> 147:2
195:17 204:11	<b>intake</b> 60:22	148:17
221:10 242:6,24,25	<b>integrate</b> 82:20	<b>into...what</b> 75:3
243:2	143:13	<b>intriguing</b> 168:22
<b>informative</b>	<b>integrated</b> 83:1	<b>introduce</b> 2:17
98:21,24 99:6	193:24	3:2,12,15 8:13
<b>ingesting</b> 133:9	<b>integrates</b> 142:24	57:16 195:4,9
<b>ingestion</b> 89:18	143:18	243:10
229:22	<b>integrating</b> 143:8	<b>introduction</b> 192:3
<b>inhabit</b> 89:15	<b>integrative</b> 47:14	<b>introductions</b> 3:3
<b>inhalation</b> 96:11	<b>integrator</b> 96:18	<b>inverse</b> 69:3
<b>inhibition</b> 144:11	<b>intended</b> 142:5	<b>invert</b> 177:3
158:11	<b>intent</b> 89:3 243:20	<b>invertebrates</b> 74:12
<b>inhibitors</b> 156:18	<b>interact</b> 166:17	157:12 160:4
<b>initial</b> 55:12 82:13	<b>interaction</b>	<b>inverts</b> 164:25
88:22 120:20	118:15 126:3	<b>investigate</b> 31:16
215:19 218:16	<b>interactions</b> 31:4	<b>investigating</b>
<b>inition</b> 100:5	74:7 75:11 191:3	226:16
<b>Inkley</b> 150:22	197:6,10	<b>investigations</b>
<b>input</b> 3:21 4:7	<b>interacts</b> 166:10	112:20 199:11
9:9 53:14 59:10	<b>interchangeably</b>	<b>involve</b> 107:12
74:3 91:11 93:11	144:9	<b>involving</b> 216:18
117:1 183:22	<b>interest</b> 110:12	<b>ion</b> 155:21
192:16	225:21 239:21	<b>ionic</b> 53:3 64:13
212:1,8,10 214:7	<b>interested</b> 85:5	<b>ionizable</b> 153:2
224:1 226:19	164:14 194:16	<b>irrigation</b>
<b>inputs</b> 4:5 51:21	208:8	230:16,21,22
53:8 82:15	<b>interesting</b> 42:23	<b>irritants</b> 156:17
116:22 117:3	43:1 62:7 69:15	<b>is...as</b> 44:20
192:20 222:10	74:1 76:23 105:9	<b>is...could</b> 130:18
223:4	115:3,17,21 147:25	<b>is...is</b> 7:11 40:5
<b>insects</b> 62:8 80:8	169:16	51:9 52:2 54:6
236:25	<b>interestingly</b> 194:5	55:9,23 56:2
<b>inside</b> 96:23	<b>intermediate</b> 195:9	57:3,24 58:8,15,24
<b>insight</b> 99:2	<b>intermittent</b>	59:6,7 60:8
<b>insightful</b> 84:21	195:5,24	63:4,13 77:10
<b>insoluble</b> 16:10	<b>internal</b> 79:15	86:16 93:5 100:5
<b>installing</b> 225:13	149:16 152:7	101:2 110:17 111:9
<b>instance</b> 43:9	<b>international</b>	112:17 116:17
<b>instant</b> 235:17	184:17 197:19	117:11,18
<b>instantaneously</b>	<b>interpret</b> 193:7	118:4,8 120:11
38:7,8	<b>interpretation</b>	<b>is...is...and</b> 54:19
<b>instead</b> 158:25	99:16 101:18,20,25	<b>is...is...is</b> 58:18
167:7	179:14 233:25	<b>is...one</b> 63:16
<b>instilled</b> 18:22	<b>interpreting</b> 98:25	<b>is...stems</b> 85:11
<b>institutional</b>	<b>interspecies</b> 81:15	<b>is...the</b> 31:12
126:18		

<b>is...we've</b> 32:18	<b>it...is</b> 40:8	122:1
<b>Is...what's</b> 107:19	54:19 133:11	124:6,19,23
<b>isn't</b> 5:24 54:13	<b>it...it</b> 53:15 62:22	125:8,22 126:20
218:24 229:6	93:17 94:6 96:10	127:4
<b>isolation</b> 97:9	<b>it...it's</b> 10:8 58:5	128:6,16,20
<b>isotherm</b> 9:8,9	91:17 94:12 128:24	129:12,13 130:3,13
10:3,7,20,25	<b>it...makes</b> 57:17	131:23 132:14,17
11:20,23 12:4	<b>it...no</b> 8:1	133:5,21 134:2
22:16	<b>it...the</b> 123:24	138:15 139:4
23:11,18,21 24:8	<b>it...this</b> 86:18	141:18 142:4
<b>isotherms</b> 10:15	<b>it...what's</b> 7:7	143:9,16,21
15:24 24:9,22	<b>it...where</b> 78:24	144:4
<b>issue</b> 3:20 8:7 18:6	<b>it...you</b> 64:3	145:9,14,21,24
21:8,23 22:1,13	<b>it...you</b> 64:3	146:13,16
32:20 33:7,8,20	<b>items</b> 89:15	147:11,23
63:6 64:18	<b>iterations</b> 93:4	148:10,21,24,25
65:13,15 76:13	<b>it's</b> 3:22 5:25	149:15,16
77:8 82:22	6:4 7:16 8:20,21	150:1,4,5
85:10,22	13:6 16:10 17:6,22	151:4,9 152:8,9
86:16,25 92:19	20:10,15 21:24	153:1,2,7 154:13
102:15 109:4	22:11,20	155:5,8,9,10,16
115:3,18 116:17	23:3,5,14,25	156:4
118:21 119:8	24:1,8,12,25	157:6,11,24
173:15 200:3 204:1	27:7,12	158:6,22
208:21 231:1,14,20	28:7,9,21	159:2,3,12,14
233:8 234:8 236:6	34:4,21 35:2 37:20	160:8,17 163:7
<b>issues</b> 2:10,23 13:4	40:23,25 41:1	164:8,12,15,23,25
49:3 52:1 53:12	42:23 43:3,20	165:24 166:9
57:9 59:18 67:8	48:16 51:17	167:23 170:10
73:12 75:17	54:21 55:21 58:4	171:3 172:17
76:14 82:25 87:4	59:2 66:10 68:1	173:24 174:19
88:15 90:23	69:9 70:1 71:20	176:7,9
91:21 109:21	73:12,25 74:17	177:1,21,22
116:18 137:18	77:11 80:3 81:5	178:2,9,16,24
139:14 163:23	87:18 88:4	179:8 181:16,20
164:18 216:14,23	89:1,2 90:19	182:11 191:1
217:1,13 222:9	91:10,13,25 92:2	192:6,21,23,24,25
231:9,11 235:8	94:11,13,14	197:4 198:15,25
237:16,20 240:12	98:10 99:6	201:7,8
243:25	100:12	205:21,24
<b>it...and</b> 92:16	103:5,17,18,19,23	206:3,6,9,16 207:4
<b>it...as</b> 38:25	105:2,7,13,24	211:23 212:2 213:2
<b>it...does</b> 40:4	106:12 107:4	214:10 219:17,24
<b>it...I</b> 40:4 73:15	109:4,20,23	221:8
124:19	110:3	222:7,22,23,24
<b>it...if</b> 44:17	114:5,13,23	223:8 226:8
<b>it...in</b> 105:13	115:14,17,18,21	229:1,11 230:15
	118:11,15 121:4,12	232:20 233:10,11

234:10 238:6,10,11	90:9	98:3 103:7
240:2 243:12	<b>justified</b> 7:11	107:20 109:22,23
<b>it's...and</b> 86:18	<b>juveniles</b> 158:24	<b>kinetics...the</b>
<b>it's...it</b> 105:1		97:21
<b>it's...it's</b> 93:19	<hr/> K <hr/>	<b>Kirby</b> 48:11
97:17 99:5 120:5	<b>KAW</b> 186:15 187:2	<b>KM</b> 63:10
129:15 133:25	<b>KD</b> 9:14 35:18	<b>knew</b> 217:21
<b>it's...it's...and</b>	<b>KDOC</b> 25:24,25	<b>knowledge</b> 52:23
85:19	26:1,3,8,9,13	91:8 222:10
<b>it's...it's...</b>	<b>KE</b> 34:1	<b>known</b> 186:18 221:21
<b>it's</b> 51:16	<b>Keith</b> 18:12 25:9,14	<b>known's</b> 221:18
<b>it's...you</b> 74:17	74:1 84:17 173:7,8	<b>KO</b> 187:2
<b>I've</b> 23:21 26:20	175:11	<b>KO...KDOCs</b> 26:5
34:24 43:2 53:2	<b>Keith's</b> 18:8,9	<b>KO...KOW</b> 114:13
62:3 63:20 87:1	164:7	<b>KOA</b> 24:8
113:5 152:23	<b>Ken</b> 62:4	91:2,13,16,17
158:18 161:25	<b>Ken's</b> 209:8	92:15 95:19
164:5 227:1 235:1	<b>key</b> 191:4 195:19	96:21,22
	202:10 206:3	100:3,7,15,25
<hr/> J <hr/>	218:19	101:23,25 102:7
<b>James</b> 48:11 70:6	<b>kg</b> 57:13,14,18	104:25 105:2,10
<b>Jane</b> 114:3	<b>Khan</b> 3:14,17,18	107:24 111:1
<b>Jason</b> 115:1	4:6,9,15 213:18,21	113:20 186:16
<b>Jay</b> 180:21	214:15 215:5,8	187:16 188:17
<b>Jepson</b> 20:8	<b>kid</b> 184:12	196:20 197:2
<b>Jim</b> 48:11 66:1	<b>killed</b> 157:6	<b>KOA/KOW</b> 131:24
70:5,7 141:9 159:7	<b>kills</b> 32:11	<b>KOAs</b> 24:3,4
164:2,20 165:5	<b>kilogram</b> 68:25 69:6	<b>KOC</b> 24:7 26:2
171:12 176:21	<b>kilogram-day</b> 69:4	34:1 36:20 37:15
214:18	<b>kilometer</b> 87:15	<b>KOCs</b> 36:22,23
<b>Jim's</b> 165:16	<b>kilometers</b> 181:9,19	<b>KOW</b> 9:13 26:10,23
<b>job</b> 66:2 70:8	184:22 193:14	34:25
72:2 77:20 164:2	206:16 208:6,13	53:14,20,23
205:6 217:24	<b>kinds</b> 45:11	54:16,20 56:12
221:24 231:10	113:10 132:19	58:6
234:22 235:6	169:8 172:9	71:12,17,19,21
236:22	211:9 223:5 232:25	73:2 74:21 77:1,23
<b>John</b> 62:5 75:12	236:1,19 239:7	78:4,16 79:1,10,12
165:1 168:12,13	<b>kinetic</b> 77:24 79:24	80:2,13,18,23 91:2
<b>Johnny</b> 166:11	97:21 102:15,25	92:16 94:21
<b>jointly</b> 215:13	<b>kinetically</b> 109:4	95:3,19
<b>judgment</b> 152:13	<b>kinetically-derived</b>	100:3,12,22
154:6	55:22	102:19,21
<b>jump</b> 67:18 217:10	<b>kinetics</b> 14:25 23:4	103:1,6,9,12
<b>just...a</b> 72:23	49:18 55:18 63:2	104:25
<b>just...if</b> 121:23	73:19 78:1,17	105:2,6,10 110:8
<b>just...just</b> 48:21	79:4,7,15 80:22	111:2 132:4 173:24

178:23	<b>largest</b> 55:10	<b>learned</b> 43:2
<b>KOW...and</b> 34:24	<b>last</b> 13:6 19:3	<b>learning</b> 163:17
<b>KOW-based</b> 56:13	40:19 49:20	220:5 243:15
<b>KOWs</b> 54:19 74:5	54:18 58:13	<b>least</b> 7:10 20:2
78:8,13 79:15	72:9,20 74:7 90:12	25:3 41:25 43:2
160:18	94:20 127:15	68:15 72:20 73:3
<b>Kye</b> 211:5	135:14 179:13	76:25 81:9 92:24
	203:25 217:12	93:11 95:10,11
	218:25 226:25	98:4 102:7
L	234:13 235:15	108:21 109:5,9
<b>l/l</b> 19:11	242:17	113:1 120:20
<b>La</b> 185:9 202:8	<b>late</b> 94:20 182:16	122:23,25 125:15
<b>lab</b> 51:4,19 52:10	<b>later</b> 24:3,5	130:18 134:4
143:23	97:14 126:10	135:18 137:13
<b>lab...lab</b> 81:18	143:11 157:4 163:2	152:24 162:3
<b>lab-derived</b> 18:16	221:11 232:17	173:21,24 175:7
<b>labels</b> 14:4	<b>latitudes</b> 184:1	177:12 178:21,25
<b>laboratory</b> 18:21	<b>law</b> 188:17	179:14 186:22
19:2 47:10 67:19	<b>Lawrence</b> 26:12 27:6	189:2,3 218:22
87:22 112:24 141:6	<b>lawyers</b> 241:18	220:22 236:19
<b>laboratory-based</b>	<b>layer</b> 30:5	239:16
66:25 67:3	31:2,12,13 33:23	<b>leave</b> 43:16
<b>lack</b> 172:6 238:14	34:3 37:18 38:10	113:17 134:22
<b>lag</b> 14:7	43:14 44:5	168:14 172:11
<b>lake</b> 80:6 195:15	202:13 203:1	216:1
<b>lakes</b> 181:18	<b>layers</b> 30:9,11,12	<b>leaves</b> 91:19 94:6,7
182:11,24 183:13	31:3,12	111:4 114:18
194:14,19 212:7	<b>lays</b> 219:23,25	<b>leaving</b> 38:12
213:12	<b>LC</b> 150:15	<b>length</b> 118:6 170:23
<b>land</b> 32:9 203:19	<b>LC50</b> 142:12 143:5	<b>Lens</b> 150:24
210:19	150:5	<b>less</b> 23:16 68:13
<b>Landon</b> 154:10	<b>LC50s</b> 148:20	73:2 75:3 91:16
<b>Langmuir</b> 23:21	<b>LC01</b> 175:19	94:24 102:8
24:23,24	<b>leaching</b> 30:4 229:4	122:8 142:17
<b>language</b> 51:1	<b>lead</b> 4:25 48:6	152:16 154:25
<b>large</b> 49:17	90:7,11,16 141:9	155:1,3
107:7,10,11	158:12 180:17	<b>lesson</b> 123:16
124:5 142:25 143:7	217:6 227:12	<b>lessons</b> 221:16
171:10 177:5 190:1	<b>leads</b> 191:16 232:22	<b>lest</b> 200:1
199:7 213:2,11	<b>leaf</b> 106:9,12	<b>lethal</b> 144:2
214:8,10,18 230:22	113:21 115:16	159:14,19,24 160:1
<b>largely</b> 64:12	120:25	169:15,18 170:1
161:15 190:18	<b>leaked</b> 70:18	176:6
<b>larger</b> 39:19 125:12	<b>leaky</b> 70:14	<b>let's</b> 34:13 76:11
126:3 141:18	<b>leap</b> 234:10	116:7 119:14
157:15 158:21,24	<b>learn</b> 98:16 157:1	122:12 139:6 140:5
162:20 179:4	220:2 243:14	144:21,23 146:6
237:16		

166:23 199:13  
 215:15 243:18  
**let's...let's** 89:9  
**level** 10:12 60:25  
 61:9,13,15 67:21  
 88:2 94:10 98:4,19  
 106:6,17,19 109:17  
 110:8 119:20  
 120:20 125:15  
 128:2,12 131:5  
 134:14 158:12  
 163:24 176:23  
 178:2 179:2  
 192:5 205:12 206:6  
 217:13 231:25  
**levels** 61:8 70:24  
 71:7,8,10 80:10  
 100:20 119:21  
 131:9 132:16 134:8  
 166:18 191:25  
 205:10 222:16  
**liaison** 239:21  
**lichen** 118:13,14  
**lichens** 19:22  
**Lick** 15:9,10,12  
 17:3,15,20,24 18:2  
 20:4  
 24:14,16,17,20  
 27:1,2,3,9,15  
 28:12 30:1,21,23  
 34:3,7,19,20  
 35:10,12,19,21  
 41:19 42:1,6,18,23  
 43:6 44:8,20 67:24  
 207:8  
**life** 59:21 60:3  
 62:25 76:13 101:23  
 124:14,15 135:6  
 161:22 164:7 175:6  
 184:16 198:14  
 215:3  
**lifespan** 80:16  
**lifetime** 97:25  
 161:11,13,19 162:4  
 195:3  
**lifted** 222:11,14  
**like...I** 42:17  
**like...it's** 97:3  
**like...like** 119:3  
**like...such** 57:2  
**like...they** 78:9  
**likelihood** 205:9  
**likely** 32:14  
 94:23 96:13 111:23  
 127:8 188:21 189:2  
 196:2 218:11  
**likewise** 97:21  
 168:2  
**limit** 9:25  
 17:2,25 18:3  
 19:9 100:13  
**limitation** 120:14  
 153:11  
**limitations** 47:19  
 52:23 90:6  
 140:25 141:4 142:9  
 149:5 151:24  
 152:1,21 159:6  
 160:24 180:8  
**limited** 49:25  
 91:8 151:3  
**limits** 17:14 162:19  
**Linda** 208:17,18  
**line** 17:13 140:3  
 146:4 207:16  
**linear** 10:15  
 15:13,18,19  
 16:22 23:15 24:9  
 197:4 211:8  
**linearity** 23:18  
**lines** 82:4  
**link** 135:20  
 208:24 225:10  
**linked** 83:4  
**linking** 180:3  
 200:6,9 225:11  
**links** 236:20  
**lipid** 55:25 56:4  
 76:12,22 77:8,9,13  
 155:14 165:3,11  
 168:20 171:1  
 177:15 187:19  
**lipids** 151:7  
**lipid's** 77:16  
**Lipids** 96:3  
**lipoidous** 176:17  
 177:4  
**list** 18:9 169:8  
**listed** 68:11 92:25  
**listening** 138:2  
 226:25  
**liter** 19:13 68:25  
 69:6 154:2  
**literally** 43:12  
**literature** 21:25  
 76:19 107:22  
 112:21 113:6  
 120:1,5,18  
 159:21 182:13  
**liters** 19:13 69:4  
**little** 9:1 10:19  
 11:10,13 23:2  
 27:20 41:25 44:4  
 53:25 61:24  
 62:10 65:11  
 67:18 69:13  
 73:16 75:20 76:5  
 82:9 83:16 88:25  
 94:12 97:1,13  
 101:3 107:15 109:4  
 110:4 120:23  
 121:16,17 127:13  
 130:22 137:18  
 139:8 141:14  
 143:11 145:21  
 162:13 163:6 166:2  
 169:22 173:2  
 175:10 186:19  
 207:15,19,22  
 216:3,4 219:8,12  
 223:12 235:11  
 240:7 243:25  
**live** 152:1  
**lively** 48:10  
**liver** 132:8  
 134:16,22 170:24  
 176:25 177:15  
 179:9  
**lives** 192:19 229:11  
**living** 174:11  
 208:10

**load** 6:18 48:8 198:10,12,18,20,22 141:20,23 142:1  
**loaded** 107:4 199:1,4,24 144:4 148:8  
**loading** 62:18 200:9,14,25 150:16,25 151:5  
65:15,16 76:16 201:15,22 202:5,15 153:4 157:17  
84:9,12 206:16 208:11,25 159:20,23 160:13  
**loadings** 212:5 211:20,23 215:6,20 163:21 169:10  
**local** 129:22 216:16 218:7 221:5 170:12 198:2 204:5  
180:3 200:6 204:2 223:16 224:12 215:2 218:2,21  
**localize** 204:19 225:9 226:13 219:4,24 220:25  
**localized** 22:9 237:8,20 239:14 224:25 230:23  
**location** 85:25 99:8 237:23 241:22  
190:15 **long...long-range**  
83:22  
**LOERs** 150:13 **longer** 16:18  
**log** 53:20,23 60:24 93:23  
54:16 73:2 74:4 124:7 154:15 195:4  
77:23 78:3,8,13,16 236:15  
79:1,10,12,14 **longer-term** 5:9  
80:2,13,18,23 **long-range** 65:12  
94:21 95:3 83:19 91:25 109:18  
100:3,7,12,15,22,2 123:6 136:8,13  
5 101:23,25 137:13  
102:7,19,21,25 **long-term** 33:6  
103:6,9,12 110:7 124:12 125:10,11  
132:4 148:11 **long-winded** 129:6  
173:24 178:23 **loops** 97:11  
186:14,16 187:2 **loose** 173:23  
**log...at** 102:21 **Lorenz** 226:2  
**log...low** 100:12 **lose** 66:21 70:14  
**logical** 164:12 **loss** 40:18,23 41:22  
**long** 20:16 28:24 101:1,10  
29:4,7 43:11 55:21 **losses** 161:21  
83:10 97:15,25 **lost** 125:22  
110:21 112:3 167:23 169:8  
119:22 121:5 **lot** 12:21 15:15  
124:22 128:21 16:8,19 26:18  
145:8 149:1 152:14 27:17 30:24  
154:20 157:8 158:7 32:9,18,19,23  
159:13,16 173:13 40:23 43:2,3 46:13  
175:5 50:10 56:14  
179:17,20,21,24 59:10 64:18  
180:1,6,8,23 70:14 71:18  
181:4,8,11,14 73:19 74:6 85:10  
182:12,17,18 101:9  
183:17,24 120:1,15,18 121:12  
184:14,24 186:9 124:6 125:13  
189:7 191:10,17 134:3,4 138:13,14  
192:3 193:17 194:6 **lowest** 150:13  
178:12  
**low-hanging** 125:13  
**low-level** 128:6  
**LPP's** 47:1  
**LR** 146:1 148:9  
149:23  
**LRP** 205:8,13  
**LRT** 97:19 98:25  
123:14 202:2  
216:22 221:17  
232:4  
**lump** 160:4 213:4

<b>lunch</b> 138:10	81:3,4,6 85:9	19:14 21:13
139:6,9 180:11	86:16 88:7	33:20 70:18 74:8
<b>luncheon</b> 139:10	100:21 101:8	75:24 176:17,18
	102:17,24 103:12	190:15 237:4
	111:24 112:13	<b>materials</b> 74:25
<hr/> M <hr/>	117:19 118:22	219:3 240:15
<b>machines</b> 220:9	119:7 129:13	<b>mathematical</b> 146:14
<b>Mackay</b> 78:7	133:15 134:17	<b>Mathematically</b> 68:1
<b>Mackay's</b> 9:3	<b>mammals...mammals</b>	<b>Matina</b> 114:3
82:22 156:12	62:12	<b>matrix</b> 41:10,19
174:23	<b>managed</b> 53:4	42:15 45:10
<b>macrophyte</b> 59:12	<b>management</b> 205:2	<b>matter</b> 13:5
<b>Maddalena</b> 90:19	219:4 232:13	16:6,15,19 17:18
95:17,18 104:7,8	233:11	23:17 26:19 59:2
105:19	<b>managers</b> 7:18	67:12 74:22
106:3,4,20,22	233:22	152:3 196:25
107:3,5,21	<b>manager's</b> 135:19	205:10 229:25
108:12 121:13,14	<b>manner</b> 33:16 52:1	230:24
129:9 135:14	207:25	<b>maximize</b> 227:5
217:7,8 220:17	<b>manually</b> 214:24	<b>maximum</b> 102:4
<b>Maddalena's</b> 129:16	<b>map</b> 176:9 186:11	<b>may</b> 4:12
<b>magic</b> 187:12	<b>maps</b> 189:1 209:23	7:5,12,22 10:21
<b>magnitude</b> 20:6	<b>marching</b> 26:23	18:11 19:4,6 20:18
142:11,13,17	<b>marine</b>	22:7,9 43:19 56:21
156:14 162:4,20	62:13,14,17 81:3	57:5 60:3,24
170:16	111:18 162:5	65:1 67:22 68:4
<b>main</b> 29:21 62:24	<b>marker</b> 187:13	69:25 72:16
85:7 95:25 96:2	<b>marketplace</b> 240:18	76:24 79:10 83:1
105:3 147:8	<b>marshy</b> 228:25	85:1 86:17,23
161:7 190:11,14	<b>Martin</b> 211:6	87:23 90:2 96:11
<b>mainly</b> 98:16 188:16	<b>Mary</b> 114:3	97:25 100:10 101:4
190:10 212:2	<b>mass</b> 9:14 14:14	102:8 105:1,12
<b>maintain</b> 25:5	37:24,25	107:12 112:11
<b>major</b> 34:16 43:8	38:4,5,7,8,11	114:16 122:7
58:15,20 180:5	74:11 96:12	123:10 126:1
200:7	97:22 98:12,19	127:1,8,10,12,18
<b>male</b> 76:14	99:7 106:8,10	131:8 136:2
<b>mammal</b> 60:19	115:13	138:1,2 140:3,17
62:14 105:23	125:5,10,11,19	148:2 150:8
112:25 129:25	126:2,7,10	152:22,23 153:6
134:17,18 161:16	127:16 128:2 169:6	154:15,25 155:6
162:5 219:3	186:5,6 201:25	156:5,7 158:21
<b>mammalian</b> 115:20	202:24	170:3 171:24 175:2
121:9	<b>mass-based</b> 68:16,20	179:4 180:14
<b>mammals</b> 49:25 53:23	<b>massive</b> 70:15	181:18 183:24
60:1,7,24	<b>match</b> 107:16 152:25	199:15,17 207:21
61:3,17,19	<b>material</b> 9:5	215:3 219:2 226:21
62:1,13,17		

234:23 237:17	<b>means</b> 54:23 63:9	<b>medium</b> 164:19
238:13,20 240:17	103:21 116:24	<b>meeting</b>
<b>may...their</b> 97:25	158:10 177:8	2:2,7,9,14,22 3:13
<b>maybe</b> 7:9 29:3 31:2	<b>meant</b> 220:8	5:11 6:12 46:3
43:19 46:3 50:25	<b>measure</b> 13:8	92:20 139:13 167:2
51:17 61:10 67:4	20:18 25:21	244:5
75:15 76:4 82:7	45:2,3,6,7 51:4	<b>meets</b> 87:20
84:5 87:19 88:3	65:6,7 143:14,25	<b>Mehta</b> 44:9,10,13
92:5 110:15 114:21	171:22 177:19,25	46:6 211:12,13
135:19	178:24 193:4 203:4	212:11
137:16,22,24	<b>measured</b> 19:1	<b>members</b> 4:13,23 5:3
138:1,6 143:23	21:9,10,11 141:4	7:21 77:6 133:2
144:24 151:20	153:8 162:20	175:22 215:6,14
177:16 208:15	172:8,25 173:25	230:6 238:3
212:7 216:4	177:22 198:6,13	<b>membrane</b> 75:17
224:6 226:1	203:11 208:5	93:18 155:6,11
227:4 228:12,25	<b>measurement</b>	166:8
230:2,6 231:25	18:20,25 20:1	<b>mentally</b> 19:12
240:2,22	173:15 174:7	<b>mention</b> 46:7 93:9
<b>McCarthy</b> 31:23	193:25 210:14	171:7 177:17
<b>McCarty</b> 156:12	<b>measurements</b>	209:13,15
174:23	174:2,9 175:8	211:14,16 218:7
<b>Meador</b> 161:2,5	196:12 199:19,23	<b>mentioned</b>
<b>Meador</b> 48:11 70:6,7	203:13 204:2	25:14,24 51:24
71:11,23 72:6	<b>measuring</b> 128:23	57:6 92:23
87:7,9 141:9,10	176:2 177:17	112:10 119:5
168:8,9,12	195:14 197:17	154:25 156:19
171:11,12 175:25	<b>meat</b> 138:13	180:11 211:2,14
176:1 239:12,13	<b>mechanism</b> 84:8	226:5
<b>mean</b> 5:25 6:24	94:24 95:1 100:6	<b>mentioned...and</b>
9:8 10:4 12:23	101:10 133:6	87:19
13:2,11 15:22	144:5,7,16,19	<b>mercury</b> 87:2
18:13 20:5 28:20	145:2,7 149:25	<b>merged</b> 150:23
29:4 30:14 35:17	155:4 156:8 167:21	<b>merit</b> 230:5
40:2,5 42:16 50:12	174:20 175:3	<b>meso</b> 181:15
84:3 114:21	183:19	<b>mesocosm</b> 19:18
147:4 148:13,21	<b>mechanisms</b> 95:19	51:10 71:9
151:9 153:20	114:8 132:10	<b>message</b> 193:10
155:18 157:2	144:14,19 153:16	<b>metabolic</b> 49:16
165:17,18 166:6	154:8 156:20,23	63:17 81:4 103:2
172:11,16 173:3	166:13 176:8	111:20
176:2 177:6,12	212:14	<b>metabolism</b> 63:22
181:4,11 192:23	<b>mechanistically</b>	67:7 69:14
205:20 214:10	13:19 166:7	74:14,15 81:9
222:15 230:6 232:1	<b>media</b> 78:11,15 97:5	101:5,13,17
<b>mean...and</b> 27:4	185:23 188:4 189:3	102:1,6,9 111:7
<b>meaning</b> 9:20	<b>medications</b> 167:14	112:6,12 121:7

136:3 214:16 238:7	<b>Mexico</b> 182:12	<b>minus</b> 113:10
<b>metabolite</b>	<b>microcosm</b> 70:13,15	<b>minute</b> 11:16 215:15
149:12,19 161:23	<b>microcosms</b> 51:6	<b>minutes</b> 77:4
239:2	<b>micro-</b>	88:18 244:1
<b>metabolites</b> 64:7	<b>encapsulated</b> 133:9	<b>miss</b> 227:6
150:3 151:13	<b>microextraction</b>	<b>Mississippi</b> 7:9
154:24 168:25	74:2	226:8,11
238:9,12,19	<b>microextractor</b>	<b>misunderstood</b> 7:23
<b>metabolize</b> 101:8	72:10	<b>mix</b> 51:5 86:23
112:14 155:1	<b>microextration</b>	201:10
<b>metabolized</b>	25:20	<b>mixed</b> 22:11 38:9
101:15	<b>microfilic</b> 170:22	<b>mixes</b> 202:12
111:11,14,23	<b>micrograms</b> 171:17	<b>mixing</b> 29:24
113:3,8 149:7,8	<b>micro-meteorology</b>	30:13 86:19
163:5 169:11	201:13	96:14 160:12
<b>metabolizing</b> 63:25	<b>micromoles</b> 155:13	191:18 201:11
<b>metallic</b> 153:2	<b>micron</b>	<b>mixture</b> 144:25
<b>meteorological</b>	27:10,13,21 28:3	167:15,18
204:2	75:3	<b>mixtures</b> 144:4,21
<b>meteorologically</b>	<b>microphone</b> 26:16	145:8 150:3 167:12
185:8 192:1	92:13	<b>mobility</b> 103:20
<b>meteorology</b>	<b>might...might</b>	125:8 195:17
185:10 202:21	117:23	<b>mobilized</b> 201:25
<b>meter</b> 192:13	<b>might...please</b>	203:22
<b>meters</b> 43:12	44:12	<b>mod...you</b> 202:7
107:9 184:20	<b>mike</b> 11:13	<b>mode</b> 79:17 85:2
192:10 202:14	<b>milk</b> 161:17	91:11 144:5,7,9,18
208:5	<b>million</b> 19:12	145:7 149:25 155:9
<b>method</b> 25:16	<b>mimic</b> 23:2 96:7	156:6,13 166:4,8
47:20,21,23	<b>mimicking</b> 132:4	167:1,5,16,20
48:17 64:24 235:24	<b>mimics</b> 23:20	174:20 175:2 176:7
<b>methodology</b> 175:18	<b>mind</b> 51:8 137:21	240:24
<b>methods</b> 46:25 47:11	152:6 153:8	<b>model</b> 9:15 10:3
48:2 50:24	156:2 158:6	11:18,22 12:7
66:23,25 67:19	171:18,20 227:8	14:3,12,13 17:8
72:5,14 89:22	228:13 236:6	18:24 21:4,5 22:16
103:16 117:2 120:3	237:23 240:3	23:1 26:9 28:18
141:2 175:14,21	243:24	29:4,6 30:16
176:2 216:20 217:4	<b>mine</b> 102:17 130:8	31:5,15 35:22
220:20 233:25	203:13	37:11
234:15	<b>mineral</b> 196:25	40:17,18,22
<b>metric</b> 96:25 142:19	<b>minimum</b> 52:3 99:1	41:21 44:4,14,15
143:20 163:11	<b>mining</b> 172:22	45:8 46:7 49:14
170:15 179:5	<b>mink</b> 62:14 87:2	52:11,16
<b>metrics</b> 142:5,16	<b>minor</b> 17:7 93:11	53:4,7,9,14,17
146:1 150:13 151:9	149:1 234:9	57:1,2,10,17,21
186:7		58:25 60:4,5,11

62:5 64:8 67:7	87:5,24,25 98:23	213:1,11 214:3
68:12,14,19,22	100:24 105:4	219:16 220:7,8
69:17 73:6,12	117:4,15,22 127:19	221:6,18 222:10
76:1,2,21 77:8	131:4 134:10	225:10,11,16,25
79:3 82:20 84:8	135:24 136:4,17	226:5,16 231:3
85:11,18 93:4	153:7 157:22	232:19
98:12 103:19,24	162:11 164:16	<b>modes</b> 144:12,24
104:12,17	176:10 180:5 189:9	153:15 154:8
105:20,24 108:3,15	192:21 195:14	156:11,19,20,23
109:1,18 116:19	196:12 199:23	<b>modification</b> 83:7
117:5 122:22	203:14 204:3	<b>modifications</b> 84:25
123:21 124:2 125:9	209:17 212:21	<b>modified</b> 62:3
126:13,25 127:18	224:11 225:12	219:16
128:1,3,11	<b>models</b> 6:13 11:11	<b>modify</b> 11:24 20:5
135:10 137:14,20	26:22 30:4 49:14	36:21
147:8 155:25 156:1	51:21 52:3,21 53:2	<b>modules</b> 46:7
163:8 166:25 167:4	54:9 57:24 58:21	<b>molecular</b> 108:15
173:17 187:1	59:6 61:20	<b>molecules</b> 199:18
190:3,5,8,19	62:2,11,19 63:11	<b>mollusk</b> 155:20
192:1,5,9,15 193:3	64:6,9,12 66:18,19	<b>mollusks</b> 80:9
194:7 195:1	68:17,20,21	<b>moment</b> 51:8 209:3
197:1,2 198:6	72:24 73:5 74:20	<b>mom's</b> 207:11
199:5 202:4 203:14	77:9 78:2 82:7	<b>Monday</b> 33:12
207:4,19	84:25 88:6 90:5	<b>monitoring</b> 6:3
214:1,22	92:24,25 93:10	179:24 193:17
218:14,16,19	95:9,10 98:19 99:1	209:17 225:9
219:17,18,19	100:5 101:5,16	<b>Monte</b> 193:3 214:23
220:4,5	102:11 104:16	<b>month</b> 227:5
222:5,6,8,19,20	106:15 108:18	<b>months</b> 43:2
223:1,3,4,7 232:18	111:9	<b>Moreover</b> 206:17
238:23 243:3	119:3,18,21	<b>morning</b> 2:4,16,20
<b>model...and</b> 127:24	120:20,23	3:1,6,11,16 5:17
<b>model...is</b> 57:25	127:16,20 129:23	64:18 89:6
<b>model-based</b> 47:11	133:17 135:9 136:5	125:18 138:24
<b>modeled</b> 57:13 112:1	142:25 167:10	216:2,5,9 243:19
162:2 202:7	185:1,8,9,14,15	244:4
203:9,10	186:8 189:16,22	<b>mortality</b> 150:18
<b>modelers</b> 52:6 62:14	190:1,2,10,18,22	153:25 155:11
<b>modeling</b> 13:17	191:1,8,16,18,24	158:12 159:16
14:16 31:23 32:4	193:12 194:8,10,23	<b>mostly</b> 41:12
46:14 49:5	195:6,11,16,20	48:19 77:21 180:25
51:14,19,24	196:4,9,10,17	188:10
53:16,22 57:11	197:13,15	<b>motion</b> 212:15
60:10 61:2,10	198:3,6,20	<b>mountain</b> 80:7 186:3
62:17 65:17	199:9,10 201:16,18	<b>mountains</b> 183:8
67:10,13 70:25	202:2,6,9,17,20,23	<b>move</b> 3:5 22:22
71:8,14 82:2,10	203:11,15,18,21	
83:3 85:9	208:25 212:25	



<b>non-aqueous</b> 47:7 140:11	<b>note</b> 173:9 180:11 206:4 240:17	<b>oceans</b> 183:18 211:14,22 213:13
<b>non-aromatic</b> 78:22	<b>noted</b> 180:23 184:19 189:25 194:19	<b>octanal</b> 186:16 187:3,17,19 192:16,17
<b>nonetheless</b> 103:5 182:4	<b>notes</b> 121:21	<b>octinol</b> 96:4
<b>non-lin...non-linear</b> 24:21	<b>notes...is</b> 34:25	<b>OCTOBER</b> 2:3
<b>non-linear</b> 10:7 11:22 12:1 15:13,24,25 16:16 20:9	<b>nothing</b> 204:13 205:19 206:19 224:23 244:2	<b>odd</b> 153:3 155:8
<b>non-linearity</b> 16:4	<b>notice</b> 141:15	<b>OECD</b> 27:12 192:4 193:11 198:16
<b>non-metabolizing</b> 69:24	<b>noticed</b> 190:9,16	<b>of...as</b> 70:22
<b>non-PBT</b> 83:15	<b>notion</b> 174:18,21 175:7	<b>of...of</b> 14:18 19:10,20 23:12 53:13,15 54:11,23 55:21 58:20,23 59:14 60:23 61:19 67:15 72:21 74:3,23 76:22 79:17 91:3 95:9 100:4 101:4 103:11 110:12,13 112:2 115:7,15 119:16,21,25 120:18 121:24 129:12 130:13 133:7
<b>non-persistent</b> 29:10	<b>nowadays</b> 45:12 146:16	<b>of...of...of</b> 57:18
<b>non-spawning</b> 177:1	<b>num...a</b> 57:8	<b>of...or</b> 91:11
<b>nonspecific</b> 155:5,9,10,19 156:6	<b>numerous</b> 100:14	<b>of...Ross</b> 90:20
<b>non-steady</b> 49:12 190:19	<b>nutrient</b> 59:10	<b>of...there's</b> 36:18
<b>nor</b> 61:11 218:25	<b>nutrients</b> 226:20	<b>of...this</b> 80:19
<b>normal</b> 195:6	<hr/> <b>obviously</b> 21:12 34:16 38:25 39:15 40:6 46:13 48:23 74:17 87:5 154:5 157:11,13 160:4 174:1 176:16,24 177:23 211:17 218:2 232:1,24 236:4	<b>of...you</b> 55:19
<b>normalize</b> 16:3	<b>obviously</b> 21:12 34:16 38:25 39:15 40:6 46:13 48:23 74:17 87:5 154:5 157:11,13 160:4 174:1 176:16,24 177:23 211:17 218:2 232:1,24 236:4	<b>offer</b> 3:11 5:1
<b>normally</b> 148:10,11 242:25	<b>obviously</b> 21:12 34:16 38:25 39:15 40:6 46:13 48:23 74:17 87:5 154:5 157:11,13 160:4 174:1 176:16,24 177:23 211:17 218:2 232:1,24 236:4	<b>office</b> 33:12 207:9 239:22 240:6,9 241:7
<b>Norstrom</b> 31:19,20 62:4 63:21 77:18,19 81:22 86:2,4 90:19 99:23,25 100:2 104:6,22 105:7 110:23,24 113:14 115:22,24 118:7 129:9,11 131:13 132:25 168:15,16 171:6 178:14,15 179:8 238:4,5	<b>obviously</b> 21:12 34:16 38:25 39:15 40:6 46:13 48:23 74:17 87:5 154:5 157:11,13 160:4 174:1 176:16,24 177:23 211:17 218:2 232:1,24 236:4	<b>Official</b> 2:7
<b>Norstrom's</b> 171:13	<b>obviously</b> 21:12 34:16 38:25 39:15 40:6 46:13 48:23 74:17 87:5 154:5 157:11,13 160:4 174:1 176:16,24 177:23 211:17 218:2 232:1,24 236:4	<b>offloading</b> 161:16
<b>North</b> 183:4,8	<b>obviously</b> 21:12 34:16 38:25 39:15 40:6 46:13 48:23 74:17 87:5 154:5 157:11,13 160:4 174:1 176:16,24 177:23 211:17 218:2 232:1,24 236:4	<b>off-site</b> 11:9 91:21
<b>northern</b> 85:25 195:16	<b>obviously</b> 21:12 34:16 38:25 39:15 40:6 46:13 48:23 74:17 87:5 154:5 157:11,13 160:4 174:1 176:16,24 177:23 211:17 218:2 232:1,24 236:4	<b>often...or</b> 94:12
<b>northward</b> 195:2	<b>obviously</b> 21:12 34:16 38:25 39:15 40:6 46:13 48:23 74:17 87:5 154:5 157:11,13 160:4 174:1 176:16,24 177:23 211:17 218:2 232:1,24 236:4	<b>oh</b> 37:2 121:7 133:19 142:13 166:23 170:19 181:9 187:7 190:20,22 195:1,2,4
<b>not...from</b> 129:12	<b>obviously</b> 21:12 34:16 38:25 39:15 40:6 46:13 48:23 74:17 87:5 154:5 157:11,13 160:4 174:1 176:16,24 177:23 211:17 218:2 232:1,24 236:4	
<b>not...it's</b> 71:20	<b>obviously</b> 21:12 34:16 38:25 39:15 40:6 46:13 48:23 74:17 87:5 154:5 157:11,13 160:4 174:1 176:16,24 177:23 211:17 218:2 232:1,24 236:4	
	<b>ocean</b> 181:21 183:22,23 184:4,7,10,12 185:2 188:13 192:10 199:25 211:18,19,22 212:3,6 237:7 239:16,17	

199:19,21 232:8  
 242:14  
**okay** 2:4 4:10  
 5:24 7:14  
 8:11,23 11:1  
 15:6 17:19 27:15  
 30:21 35:6,16,24  
 38:4 44:7 50:16,19  
 71:11 83:4,21  
 88:11,20 95:18  
 99:15 121:14 122:7  
 129:25 131:13  
 133:19 134:1  
 140:5,8 149:5  
 172:7 179:19  
 187:14 193:16  
 196:14 204:8  
 215:18 217:8  
 219:10 220:17  
 231:24 233:5  
**old** 39:20 105:7  
 203:13 207:11  
**older** 33:13  
 197:13 199:8  
**olfaction** 158:11  
**on...and** 92:21  
**on...on** 39:21 48:18  
 49:17 50:22 56:5  
 59:19 77:22  
 85:14 88:12  
 90:20 92:5 94:19  
 109:8 113:21  
 115:16 130:17  
 131:8 134:13  
**on...towards** 104:5  
**once...once** 22:11  
**one...one** 39:7 61:5  
 116:20  
**one-dimensional**  
 44:3 46:2  
**one-liner** 48:16  
**ones** 56:4 58:11  
 85:1 86:23  
 111:18 150:18  
 162:20 188:2,22  
 189:12,13 190:13  
 238:16  
**one's** 150:10  
**one-size-fits-all**  
 7:15  
**ongoing** 49:1  
**Ontario** 194:15  
**onto** 16:8 196:5  
**open** 5:2 51:10  
 209:5 211:18 212:3  
 239:15  
**open...it's** 12:23  
**opening** 137:4  
**operate** 195:7  
 240:24  
**operates** 144:24  
**operationally**  
 27:7 64:23  
**opine** 230:7  
**opinion** 106:24  
 177:8 205:25  
**OPP** 123:3 126:14  
 218:12 239:24  
**opportunistic**  
 118:20  
**opportunity** 4:24  
 198:5 209:7  
 228:5,22 243:9  
**opposed** 12:20  
 51:1 54:25 170:6  
**opposite** 94:13  
**OPPs** 179:23  
**optimal** 6:19  
**option** 33:25 72:16  
**options** 33:23 34:9  
**or...no** 34:5  
**or...of** 56:3  
**or...or** 54:23 55:13  
 62:2 65:7 91:21  
 116:18,23,24  
**or...or...or** 114:20  
**oral** 74:3,10,13  
 75:18 164:14,17  
**order** 20:6 22:2  
 103:22 142:16  
 156:14 162:3  
 170:16 192:18  
 195:11 202:13  
**orders** 142:11,13  
 162:19  
**organ** 135:4  
 157:24 165:16  
**organic** 13:5  
 15:14,16  
 16:6,14,19  
 17:17,20 23:16  
 26:7,10,19 27:4  
 47:6,15,24 48:3,18  
 59:9 67:12  
 70:14,17 140:10,21  
 153:2 229:25  
 230:24  
**organic...dissolved**  
 26:19  
**organics** 64:13  
**organism** 62:25  
 67:21 68:25  
 69:6,17,18,23  
 79:15,20 94:7  
 96:24 103:3,8  
 105:25 106:8 111:6  
 112:4 135:4 140:11  
 151:7 163:10  
 178:16 237:19  
**organisms** 47:2  
 49:17 54:4,10  
 55:13 60:25  
 69:25 80:17  
 101:2,11 102:16  
 105:5 116:22  
 123:11 132:1  
 134:14 135:17  
 144:1 179:4  
 237:3,17  
**organization** 65:21  
**Organized** 161:3  
**organo** 182:20  
 183:7,15 203:6  
**organo-chlorine**  
 196:18  
**organochlorines**  
 80:13  
**organo-halogens**  
 169:2 170:25  
**organs** 134:23



**part...you've** 28:4 73:4 74:15 75:15 180:4 200:6 241:18  
**partial** 24:6 76:14 164:16,18,25 **pay** 160:8  
**participating** 2:9 165:3,13 204:3 **paying** 53:19  
225:5 **particulate** 67:12 **PB** 97:19 98:25  
**particle** 9:23 **partition** 9:9 123:14  
16:5,7,13 17:17,18 10:2,15 12:3,19,20 **PBBK** 150:4 157:22  
34:23 41:24 15:18,25 16:21 173:17  
74:23 76:1 185:4 20:9 27:24 28:6 **PBDEs** 195:15 196:3  
188:19 195:24,25 29:5 55:12 56:13 **PBGs** 109:12  
196:5,17,19 96:5 98:8 108:17 **PBPK** 135:10  
197:6,11 199:7 186:15,16 **PBT** 47:6,16,25  
211:4 187:3,4,5,6,14,16, 48:18 58:16  
**particles** 9:17,19 17 188:3 192:17,18 66:24 67:2,21 68:5  
16:9 20:17,20,23 237:17 238:11 83:9 87:20  
21:2 31:10 37:24 **partition...I** 15:22 122:6,23 140:10,21  
38:23,24 41:17 **partitioned** 37:14 173:1 179:21  
42:4 74:25 **partitioning** 216:18,22 217:2  
188:18,20 15:13 21:6 26:19 234:16  
199:13,14 211:9 79:17 101:11 111:3 **PBTs** 96:8 109:19  
212:12,14,17,22 132:10,21 184:18 124:19 167:11  
239:25 240:21 186:14,25 218:11 219:9  
242:2 189:3,6 221:17  
**particular** 9:11 196:17,19 197:12 **PCB** 63:22 64:1  
11:19 15:15 199:8,10 211:4 102:17,19 112:14  
19:11 51:20 239:10 150:24 156:22  
53:12 59:21 60:2 **partly** 59:23 175:1 212:8  
67:13 71:17 **pass** 85:16,18 **PCB-180** 80:18  
76:13 97:6,16,18 117:25 **PCBs** 15:15 43:10  
100:23 104:3 **passed** 93:1 58:17 63:25 101:10  
105:17 106:5 210:20,23 104:24 131:19  
122:10,19 123:25 **passing** 27:8 112:2 153:14 195:15  
124:10 126:19 **passive** 193:20 196:18 199:17  
128:1 130:1,15 197:20,22 209:22 239:16,19  
142:4,17 158:24 **passively** 93:19 **PDPK** 75:13  
175:23 177:11,18 **past** 14:2 83:15 **peak** 60:16  
183:9 184:3 233:7 234:13 **peculiar** 169:3  
190:7,12,15 235:22 **peculiarities** 169:1  
194:1 215:3 217:23 **patching** 22:16 **pentachlorophenol**  
221:12 225:21 **path** 175:1 132:14  
234:8 238:3 242:12 **pathway** 54:6  
**particular...** 89:18 91:11  
**again** 124:4 **pathways** 48:24  
**particular...Dr** 108:20 114:10  
77:6 117:1 125:10,25  
**particularly** 49:4 127:9  
53:3 54:9,21 57:24 **patient** 167:14  
58:6 59:7 63:24 **patterns** 124:17  
**per** 69:4 75:4

124:25 154:2 184:13,17 223:25 225:19,25 226:12  
 155:13 171:17 232:2 233:13 237:7 227:14 240:1,14  
 172:4 184:20 202:5 238:13,21 **Peter** 25:8 154:10  
**percent** 17:9 34:1 **persisting** 218:6 172:2 235:9  
 57:25 58:2 223:16 **Peter's** 154:18  
 77:13,14 142:21 **person** 206:21 **pH** 166:11  
 147:1,2,23 208:15 **Ph.D** 163:15  
 148:17 149:19,22 **personally** 170:14 **pharmacists** 167:13  
 158:21 162:19 218:23 236:2 **phase** 9:4 22:4  
 171:1 185:18,19 **perspective** 135:19 69:19 70:1 72:10  
 192:7,11,12 231:11 **perspective...and** 74:2 98:18 104:9  
 239:16 75:9 187:19,20 196:19  
**percentile** 146:9 **pest** 219:3 **phenolic** 132:7  
 147:1,6 148:16 **pest...where** 91:22 **phenomenally** 221:7  
 214:7 **pesticidal** **phenomenon** 182:7  
**perception** 240:20,24 241:3 239:10  
 107:20,21 **pesticide** 14:4 22:8 **Phil** 7:22  
**perfect** 78:20 29:11 31:24 **phobicity** 238:14  
 210:16 32:16 47:1,18 **phosphorylation**  
**perform** 193:2 59:11 85:23 144:11,15  
**performance** 172:20 89:20 90:3 **photolysis** 196:1  
**perhaps** 50:6 51:7 91:12,15,22 120:16 **phrase** 191:5 205:17  
 52:7 57:24 59:13 123:5,13 133:8 241:21  
 61:16 64:2 69:23 140:14 168:21 **pHs** 153:14 156:22  
 74:20 75:14,25 180:2 200:13 201:3 **phys-chem**  
 81:18 83:8 92:6 202:11 203:4,15,19 98:10,16 104:11  
 104:22 117:25 226:20 228:6,23 **physical** 23:22  
 163:11 165:15 234:12 237:8 92:12,15 112:5  
 229:20,25 238:20 240:6,9 242:20 195:23  
**period** 22:10 **pesticides** **physicochemical**  
 43:11 180:14 224:7 2:11,24 12:23 189:18  
**periods** 164:6 47:13,15,24 **phytoplankton** 55:13  
 200:24 223:17 48:4,18 79:6 89:15 **phyto-remediation**  
 224:6 100:8 133:9 139:16 117:8  
**persist** 132:3 224:8 140:21 141:1 **pick** 54:25 165:8  
**persistence** 109:2 159:23 179:21 198:4 243:19  
 125:7 131:18,23 180:4,9 **picked** 189:17  
 137:11 185:20 182:14,21 191:24 210:21  
 189:6,24 190:7 183:2,3,7,12,15 **picking** 20:25 54:25  
 191:10 192:7 184:5 194:17 133:8 179:3  
 198:10 216:15 196:15,18,22 **picture** 129:3  
 230:2 231:15 197:8,12 197:11  
**persistent** 199:3,6,12,25 **pieces** 32:25  
 2:11,24 29:10 92:2 201:19 202:25 **pile** 163:22 227:3  
 109:24 110:6 203:7 204:7 **pinpoints** 21:3  
 111:10 132:15,17 209:1,2 210:8 **pitch** 158:14  
 139:16 183:21 216:18 217:2 224:8

**PKM** 186:14,22  
 214:14,15  
**placed** 78:5  
**places** 123:15,19  
 128:4,5 213:6  
 219:20  
**plan** 88:17 98:22  
 138:21  
**planes** 207:13  
**plankton** 50:4 53:20  
 60:10  
**planning** 138:23  
**plant** 92:21  
 93:20,22,24  
 94:1,5,20 95:4  
 97:8 108:6 109:5  
 114:1,9,15  
 115:8,11,18  
 117:6 119:16  
 120:1,3,5,9,15,21  
 125:19 126:1,9  
**planted** 207:12  
**plants** 91:15  
 93:14,16 94:11  
 107:1,19 111:4  
 113:19,23,24  
 114:5,17,19  
 116:6,21,23  
 117:8,13,16  
 121:8,10 126:16  
 127:7 134:13  
**plasma** 132:8 157:16  
**plates** 25:19  
**play** 76:24 86:18  
 161:14 206:14  
 233:6  
**played** 61:7 163:6  
**player** 91:17  
**please** 2:5 8:22  
 47:22 48:1,8  
 52:8 89:11,25  
 90:3,25 140:7,24  
 141:3,24 149:4  
 152:20 154:21  
 159:5 179:18 180:7  
 181:12 200:17  
 201:1,14 216:11,24  
 217:15 220:12  
**plot** 35:3,7,8  
 154:15 207:2  
**plots** 87:12 130:10  
**plowing** 201:12  
**plug** 58:25 59:3  
 60:20 72:4 174:10  
**plugged** 126:9  
**plugging** 75:25  
 214:25  
**plus** 29:22 229:5  
**PMRE** 172:17  
**point** 4:17 5:2,18  
 12:18 14:21,22  
 15:20 16:10 24:8  
 26:17 32:17 33:9  
 36:2 37:18  
 46:10,18 49:22  
 51:11 52:4,6 53:23  
 54:8,18 57:12,23  
 60:6,21 61:18  
 62:20 64:5,21  
 65:9,16 70:11,19  
 71:12 78:6,9 79:11  
 81:23 84:14  
 88:11,16,22  
 90:12 91:6 95:5  
 99:11,13 100:9  
 103:15 104:9  
 105:17 109:2 125:6  
 126:10 137:9  
 138:9,15 141:17  
 142:4 145:6 147:25  
 149:1 152:21  
 160:23 161:22  
 171:13 179:12,15  
 180:23 184:6  
 200:12 202:16  
 205:21 206:14  
 210:10 215:9  
 219:14 223:1 226:7  
 233:9 240:4  
**point...welcome**  
 88:21  
**pointed** 7:16  
 44:19,20 45:1 83:5  
 229:8  
**pointing** 187:9  
**points** 46:20 55:4  
 63:15 67:17  
 71:22 73:20  
 81:25 84:16  
 148:6 151:17,19  
 154:22 163:4  
 182:25 206:3  
**points...points**  
 70:9  
**polar** 53:3 63:23  
 64:2,13 81:2 110:1  
 153:2 156:17  
 170:22 197:8,19  
 199:7  
**policy** 5:20 241:19  
**pollutant** 13:4  
**pollutants** 97:19  
 107:24 182:23  
 191:4  
**Pollution** 241:7  
**polycyclic** 149:9  
 171:14  
**polygons** 128:13  
**polyparameter** 197:4  
 211:8  
**pond** 5:23,24 6:18  
 7:9 19:7,13,15  
 22:12 29:6 34:23  
 35:1  
 39:8,11,15,16,24  
 40:10 41:24 43:7  
 45:14 57:25  
 59:10 82:14  
 86:7,10 107:10  
 109:16 137:20  
 200:20 224:1  
 227:21,23  
 228:9,11,17 229:15  
 230:9,20  
**pond...right...  
 you** 37:23  
**ponds** 29:14  
 31:16,17 32:13  
 40:15 41:11 62:8  
 70:12 86:21 129:20  
**poorly** 78:24

<b>pop</b> 186:4 190:13,17,19	<b>potentially</b> 57:9 89:4 135:18 223:22	<b>preferred</b> 153:9 177:16
<b>pops</b> 182:21 196:16 197:7 199:7	<b>pounds</b> 124:25	<b>prelude</b> 141:14
<b>popular</b> 203:2	<b>PPD</b> 77:14	<b>prepared</b> 134:9 135:8
<b>popularizing</b> 186:2	<b>ppLFERS</b> 197:4 211:2	<b>preparing</b> 116:11
<b>population</b> 131:4 158:12 159:2 163:24 176:23	<b>PR</b> 33:19 35:17,22 36:19,23,24	<b>presence</b> 236:21
<b>portal</b> 12:19	<b>practical</b> 172:3 173:3	<b>present</b> 24:22 37:25 50:15 206:6 218:9 228:4,5 239:2
<b>Portier</b> 208:1,2	<b>practically</b> 111:13 213:3	<b>presentation</b> 18:9,13 48:7 65:21 161:3 175:16 204:10
<b>Portier's</b> 213:22 224:21	<b>practice</b> 124:24 228:13 230:14	<b>presentations</b> 2:14 6:11 122:21 125:17 226:25
<b>position</b> 178:7	<b>practices</b> 205:2 224:18 225:13 227:9,12 228:3	<b>presented</b> 6:16,25 30:1 32:19 36:17 73:4 164:3 167:3
<b>possibility</b> 36:15,16 45:21 101:19 149:14 157:2	<b>practitioner</b> 227:2	<b>presenter</b> 139:23 180:12
<b>possible</b> 42:2 43:20 67:22 81:5 103:19 124:16 130:3 181:21 182:11 203:12 220:25 234:20 235:1	<b>practitioner's</b> 5:18	<b>presenting</b> 57:13 164:3
<b>possibly</b> 9:7 40:5 78:14 81:6 116:4 148:6 227:6 238:20 239:3	<b>preaching</b> 164:8	<b>pre-sorbed</b> 37:16
<b>Post</b> 232:9	<b>precip...</b> <b>precipitate</b> 9:4	<b>pressed</b> 86:7
<b>potato</b> 95:6	<b>precipitate</b> 10:22 13:13 22:19 23:4 31:10	<b>pressure</b> 24:6,7 123:19 196:20
<b>potential</b> 7:18 47:2,15,24 48:3 51:25 59:14 67:1 70:1 72:4 74:3 90:1 93:25 115:4,15 133:14 135:20 137:6,11 179:17,20 180:1,7,9 186:3,4,5,11 187:20 189:7 190:14 191:10,13 198:12,22 199:1,16,25 200:16 201:22 205:24 234:15	<b>precipitates</b> 21:12	<b>pressures</b> 96:9 234:24
	<b>precipitation</b> 12:16 185:5 190:21 195:5,10 200:19	<b>presumption</b> 19:16
	<b>preclude</b> 149:8	<b>pretty</b> 13:22 53:1 68:3 71:22 72:13,25 73:7,8 76:10,23 87:14 96:2 98:14 108:3 112:16 114:14 144:1 156:5 158:3 164:3 165:18 179:6 203:10 205:18 219:19 221:24 223:10 231:10
	<b>predator</b> 130:17	<b>pretty...pretty</b> 73:3
	<b>predict</b> 56:12 63:10 130:25 173:18 176:10 225:25	<b>Prevention</b> 241:7
	<b>predictability</b> 120:11	
	<b>predicted</b> 21:9 52:12 141:5 151:24 162:17,18 194:22 198:13	
	<b>predicting</b> 105:25 120:24 189:22 203:15,21	
	<b>predictions</b> 47:21 73:7	
	<b>predictive</b> 108:18	
	<b>predominantly</b> 86:21	

**previous** 3:13 14:15 29:21 39:3 43:24  
 72:22 54:16 56:20 57:7  
**pri...primary** 70:11 59:24 60:2 66:15  
**primarily** 52:18 85:7 98:13  
 60:20 64:2 85:8 113:19 129:15  
 99:19 123:4 211:25 162:21 212:24  
**primary** 41:3 218:12 224:10  
 74:11 125:2,25 236:10  
 126:4  
**principally** 58:16  
 62:12  
**principles** 108:15  
**prior** 164:7 180:1  
**priori** 179:25  
**prioritizing** 221:13  
**priority** 126:6  
**pristine** 239:18  
**PRN** 37:6  
**proactively** 198:23  
**prob...the** 22:24  
**probabilistic**  
 234:14  
**probability** 209:24  
**probably** 7:17 11:23  
 13:18 22:5,12  
 29:12,20,22  
 49:13 53:25 58:9  
 81:8 85:4,10,17  
 92:18 93:3  
 94:23,25 95:4,14  
 96:18 101:15  
 103:13 109:18  
 110:25 115:10  
 120:23 123:20  
 132:1,12 138:21  
 153:10 155:16  
 156:4 157:19 159:8  
 164:8 165:25  
 166:21 170:25  
 172:4 179:9 207:19  
 208:11,12 210:21  
 217:20 218:24  
 220:22 222:7  
 223:9,17 227:17  
 231:11,20  
**problem** 7:6  
 12:10,22 22:24

29:21 39:3 43:24  
 54:16 56:20 57:7  
 59:24 60:2 66:15  
 85:7 98:13  
 113:19 129:15  
 162:21 212:24  
 218:12 224:10  
 236:10  
**problematic** 54:21  
 217:1 231:9  
**problems** 10:16 14:3  
 43:8 162:10 217:22  
 233:7  
**procedure** 18:24  
**process** 2:11,24 3:9  
 5:21 9:13 12:15,16  
 13:14 17:2 44:24  
 49:12 54:23  
 55:15 62:13 91:3  
 98:12 104:16  
 106:9,11 124:18  
 132:21 139:18  
 179:23,25  
 201:2,5 212:13  
 216:21 219:19  
 220:6 221:10,19,22  
 222:10 241:24  
**processed** 163:11  
**processes** 12:14  
 94:20 96:14 97:4  
 122:14 125:7,15  
 139:15 195:19  
 218:20  
**produce** 238:24  
**producing** 63:18  
**product** 19:6,19,21  
**production**  
 59:8,12 70:12  
 101:12  
**productive** 243:13  
**products** 128:8  
 240:13,19,23  
 241:2,8 242:8,9  
**professional** 152:13  
 154:6  
**profiles** 140:10  
 216:18

**program** 34:15 47:13  
 131:3 133:21  
 197:19 199:16  
 208:22,24 224:20  
 225:6 241:12  
**programing** 11:10  
**programs** 47:9  
 140:18 240:6,10  
**progress** 57:19  
 138:12,25  
**project** 224:17  
 225:15 231:16  
**projecting** 84:7  
**proof** 178:3  
**proofing** 102:11  
**properly** 55:8  
**properties** 37:22  
 91:24 92:12,15  
 98:11,17 104:11  
 109:21 186:14,22  
 189:18,20 195:23  
 201:6 214:14,15  
 218:5  
**property** 77:11  
 190:12  
**property's** 193:5  
**proportional** 93:21  
**proportionality**  
 158:4  
**propose** 40:20  
**proposed** 13:13  
 140:19 166:25  
 234:19  
**prospectively**  
 174:13  
**protecting** 158:9  
 233:16  
**protective** 160:2  
 181:24  
**protein** 132:6,16  
**protocol** 172:9  
 173:9,22  
**protocols** 56:20  
 70:22 83:8 172:24  
**prove** 222:24  
**provide** 7:18  
 52:4,10 55:7

56:8 62:19 89:17	<b>Pyranees</b> 80:7	138:6,7 139:1,20
99:2 123:20		140:5 141:9
191:2,11 240:7		142:8 151:20,23
242:8		152:17 164:6
<b>provided</b> 65:25	<b>quadrant</b> 187:23	168:25 169:12
76:20 243:22	<b>qualify</b> 205:12	172:2 174:17
<b>provides</b> 53:15	<b>qualitative</b> 137:6	178:15 179:1,16,19
61:20 96:22 128:1	<b>quality</b> 145:16,17	200:5 204:18
<b>providing</b> 51:20	146:13,17 160:22	205:16,25 208:19
85:13	225:13,14	209:4,8,11
<b>PRZM</b> 9:7,19	<b>quantifying</b>	211:1,24 213:15,19
11:19,25 37:7,15	140:20,21	214:4,13
204:21,24 206:25	<b>quantitative</b> 200:12	215:10,12,16,20,24
207:4,19,24	207:22	216:1,10 217:9
214:6 226:3	<b>quantities</b> 113:25	220:14,15,18
242:23,24	203:21	221:13 224:20,21
<b>PRZM/EXAMS</b> 6:14	<b>quantity</b> 47:17	231:7 233:23 234:1
11:25	201:19	237:23 238:10,11
<b>pseudocholinesteras</b>	<b>QUASAR</b> 152:23	239:20 240:2,8
<b>e</b> 156:18	153:6,7 176:10	242:12,17 243:8
<b>PTBs</b> 16:22	<b>question</b> 3:10	<b>question...charge</b>
<b>public</b> 2:15 4:12	4:20,21 5:4,5,7,15	209:8
139:23 175:17	6:10 8:6,11,15	<b>question...has...</b>
180:12	12:13 15:8 17:12	<b>has</b> 62:11
<b>publish</b> 163:7	18:19 19:25	<b>questions</b> 3:4,8
<b>published</b> 136:11	25:18 26:13 27:5	4:19 10:18 25:6
194:12	33:7,14 34:14 39:5	31:18 32:22 33:1,4
<b>publishing</b> 69:1	40:6 42:1,20	46:12 61:17
<b>pull</b> 11:13 22:18	43:6,10,15,25 44:2	84:17 88:14,23
23:5 136:10 176:15	46:19,23,25	89:2,5 91:2 130:23
<b>pulling</b> 45:24 113:6	48:6,15,19,21	136:23 138:13,18
136:9	49:23	139:19 154:23
<b>punctuated</b> 234:10	50:9,10,11,12,23	167:9 173:7 175:23
<b>pure</b> 9:5 17:6	53:13 61:24	179:13 209:9
20:16,23	62:18 74:7 75:10	213:16 216:8
<b>purely</b> 103:7	84:22 85:6	217:14 221:11
<b>purpose</b> 160:14	88:13,24	242:16 243:10,20
193:20	89:10,12 92:5 93:9	<b>quick</b> 31:20 82:16
<b>purposes</b> 213:2	99:16,18	170:23 213:19
<b>pursue</b> 167:17,25	104:5,11	217:11
<b>pursuing</b> 67:9	105:8,19 106:14	<b>quicker</b> 46:9
130:13	107:1,4,17	<b>quickly</b> 34:17 45:23
<b>purview</b> 133:4	108:8,11 109:17	72:3 91:7 137:8
<b>puts</b> 33:21	116:8,12	<b>quit</b> 121:3
<b>putting</b> 12:24 27:22	121:17,19,23	<b>quite</b> 8:4 23:17
32:12 127:3	122:17 125:2	26:6 32:8 39:12
160:9 189:8	127:15 131:12	45:5 55:3 58:3
	133:1 137:12,17	

60:11 63:2,25 119:8,22 149:3 113:7 143:2,5  
 64:20 70:14 154:5 156:14 150:3 157:23 193:6  
 78:17 81:3,13 159:22 162:4,12 199:20  
 85:13 87:13 179:17,20,22,24 **rates...I'd** 41:5  
 90:16 100:20,21 180:1,6,9,23 **rather** 22:25  
 103:22 108:1 113:3 181:4,8,11,14 23:1,18 31:25 79:6  
 118:9 122:1,2 182:4,13,16,17,18 100:25 101:2  
 124:5 132:17 183:17 184:14,24 105:9,11 110:21  
 151:14 162:7 186:9 189:18 125:25 132:17  
 168:22 170:11 191:10 193:18 163:8 178:7 184:11  
 173:13 181:16 194:6 216:8  
 183:10 185:10 198:10,12,18,20,22 **ratio** 68:2 78:10  
 190:1 191:23 199:1,4,24 159:10,19 175:12  
 194:5,6 202:17 200:9,14 201:15,22 185:22  
 210:24 218:4 223:2 202:5,15 208:11,25 **rationale** 218:17  
 231:18 234:17 215:7,20 216:16 **ratios** 56:23 78:8  
**quote...hazards** 218:7 221:6,7 236:12  
 123:23 225:24 226:16  
**quotient** 88:1 227:11 228:3 237:8  
**quotients** 60:16 239:14  
 61:7,12 **ranges** 67:11 87:3  


---

 R **ranging** 51:5  


---

**rabbit** 81:19 **rank** 190:3,4,5  
**radical** 190:20 191:9,11,12  
 195:1 199:19,21 193:8 201:21  
**radically** 228:24 **ranking** 192:24  
 230:19 200:11,15  
**radicals** 195:3 **rankings** 194:5,9  
**rain** 183:22 **rapidly** 120:12  
 188:12 195:5,24 **rarely** 71:15  
**rainfall** 38:6 **rate** 6:15,17 7:11  
 190:23 192:23 14:19 28:22  
**rainstorms** 200:24 29:1,15,16,23  
**raised** 3:19 205:16 41:8,20 42:7,9  
**raising** 178:20 45:8 52:13 54:15  
**rambling** 121:22 55:25 56:5,6,23  
**ran** 31:22 57:14 58:16 59:1,3  
**random** 67:16 63:10,17  
**Randy** 90:19,21 68:2,6,11,13,16  
**Randy's** 92:17 69:2 78:10,14  
**range** 7:18 9:16 79:16 98:9  
 26:6 50:6 51:25 190:23 192:19  
 54:16 67:15 **rates** 6:22 7:2 31:9  
 75:24 79:2 39:10 41:6 42:3  
 86:17,25 87:4,14 49:16 58:21,22  
 110:14,20,21 79:13 81:10  
 103:2 112:16,23

<b>realistic</b> 140:15 195:11	220:6,8,14 221:12,17,22	<b>recommendation</b> 75:8 97:2 98:15
<b>reality</b> 6:4 22:20 23:2 49:7 95:13 222:21	222:18,21 224:9 234:16 235:16 239:8	151:18 153:11 173:23 179:4 198:11 214:9 223:10
<b>realization</b> 91:7	<b>realm</b> 49:2 167:13	<b>recommendations</b> 46:16 84:24 157:9 173:11 174:7 193:2 198:9 221:14
<b>realize</b> 109:7 148:8 220:8	<b>rearrangement</b> 146:14	<b>recommended</b> 124:24 173:24 178:24
<b>realized</b> 224:23	<b>reason</b> 24:7 56:1 79:14 95:25 104:13 135:1 169:3 191:24 212:11 229:13	<b>reconvene</b> 88:17 215:15 243:19
<b>really</b> 5:23 22:19,23 23:3,5,10,14,24 30:16 32:8,13 40:24 50:3 51:16 53:18 54:10 60:11,13,20 62:24 64:7 65:6,13 66:10 69:10 70:21,23 71:25 78:2,21 79:3 83:12 90:22 93:5 94:1 95:8,15 96:5,9 97:5 103:23 104:14 109:22 110:2 115:18 116:18 118:12,14 121:24 122:17 123:20 124:5 125:22 129:2,17 131:14 133:5 134:23 137:2,5 142:24 145:13 146:19 148:5 150:1,14 151:8 152:14,16,24 153:13,17 154:3,13,17 155:3,9,23 156:8 157:6 158:8,22,23 159:1,15 160:1,8,10 163:2,5 164:23 167:10,17,25 169:23 171:10 173:14 193:13 195:7 196:11 201:15 206:1 208:7 209:16 219:4,23,25	<b>reasonable</b> 28:1 42:4 81:20 123:1	<b>record</b> 46:23 89:11 140:7 172:5 179:18 216:11
	<b>reasonably</b> 81:17 98:21	<b>recordative</b> 146:18
	<b>reasons</b> 51:23 54:2 134:11	<b>recover</b> 70:16
	<b>recall</b> 177:21	<b>red</b> 206:7
	<b>receive</b> 36:4 220:24 240:12	<b>redistribute</b> 152:12
	<b>received</b> 240:16 241:5	<b>redistribution</b> 152:7
	<b>receiving</b> 59:10 82:12	<b>reduce</b> 76:25 83:10 168:4
	<b>recent</b> 43:13 133:22 183:10 186:11,13 189:13 219:21	<b>reduced</b> 127:12
	<b>recently</b> 149:11 153:22 183:6	<b>reducing</b> 158:1
	<b>recently...until</b> 120:8	<b>reduction</b> 142:10
	<b>recep...receptor</b> 135:18	<b>reductionism</b> 130:22
	<b>receptor</b> 126:12	<b>reemphasize</b> 129:12
	<b>receptors</b> 166:9 236:24 237:12	<b>reevaluate</b> 218:18
	<b>recess</b> 88:19 139:10 215:17	<b>refer</b> 9:2 54:11
	<b>recipient</b> 182:7	<b>reference</b> 140:16 145:21 146:10
	<b>recognize</b> 5:23 83:20 97:5 157:1 199:15 201:15	<b>referenced</b> 189:10
	<b>recognizing</b> 126:14	<b>references</b> 46:6 93:1
	<b>recommend</b> 75:13 96:20 160:15 214:11	<b>referred</b> 197:4 219:22
		<b>refine</b> 51:21 52:16 53:25 75:7 167:9
		<b>refinement</b> 234:7
		<b>refinements</b> 217:3

220:19,25 221:1  
 233:25 234:2,19  
 236:4,7  
**refining** 57:10  
 74:20 216:21  
**reflect** 23:10 57:11  
 59:1  
**refresh** 177:17  
**refute** 222:23  
**regard** 22:15  
 73:24 74:15 164:12  
 165:2,18 168:5  
 176:23 235:9  
**regarding** 4:19  
 18:15 61:17  
**regardless** 241:3  
**regards** 92:11,14  
**region** 17:5  
 72:7,8 123:12  
 185:24,25 205:23  
 209:25 210:4,6,23  
**regional** 202:8  
 203:18  
**regions** 32:10,16  
 107:8 125:3 197:17  
 200:13  
**registered** 123:13  
 233:4  
**registrant** 214:17  
**registrants** 173:3  
**registration** 140:14  
 198:23 241:24  
**registrations**  
 240:13 241:2  
**regression** 101:7  
 150:16  
**regular** 83:6  
 150:6 212:25  
**regulating** 12:23  
**regulations**  
 184:17 242:6  
**regulatory** 6:4  
 120:8 126:17  
 240:12  
**reiterate** 66:12  
 119:17 165:16  
 167:20  
**relate** 154:23  
 173:18 176:19  
 193:18  
**related** 90:23  
 163:23 216:22  
**relates** 114:19  
 176:16  
**relating** 42:9  
 108:16  
**relation** 149:13  
 204:3 209:8  
**relationship**  
 36:19,21 101:23  
 177:24  
**relationships**  
 78:4 81:12  
 113:10 141:5  
 151:25 197:5 211:8  
**relative** 15:22  
 47:18 61:8 90:6  
 102:7 110:17 118:6  
 140:12  
**relatively** 51:23  
 61:6 62:22 78:14  
 82:16 89:17  
 93:11 98:20 115:14  
 147:16 153:19  
**release** 79:18 91:18  
 180:2  
**relevance** 114:22  
**relevant** 75:20  
**reliable** 54:19 63:9  
**reliance** 68:6 78:5  
**relied** 47:3  
**relies** 179:23  
**rely** 162:11 167:8  
 201:16 219:16  
**relying** 79:9 172:12  
**remain** 218:4  
**remainder** 52:7  
**remaining** 138:18  
 206:5  
**remarks** 137:4  
**remember** 80:1  
 106:18 112:9  
**remind** 2:13 241:1  
**remote** 182:5 203:22  
 205:23  
**removal** 148:14  
**repeats** 235:21  
**replace** 142:5  
**replicate** 178:5  
**report** 46:8 174:13  
**reported** 4:7  
 55:25 242:2  
**reporting** 69:1  
**reposition** 204:22  
**represent** 40:9  
 96:1,5 123:8  
 222:21  
**representation**  
 149:16  
**representative**  
 18:20,23 39:8,25  
 43:7 118:24  
**represented** 57:25  
 96:3  
**representing** 5:25  
 86:6  
**represents** 128:14  
 193:25  
**reproduce** 3:20  
**reproduction** 150:19  
 173:23 177:8  
 178:20 236:13  
**reproductive**  
 154:1 160:7 161:21  
 176:20  
**request** 72:9  
**require** 120:9  
 172:25 178:6  
 185:11 218:11  
**required** 53:16  
 149:24 213:1  
**requirement** 87:21  
**requirements** 83:9  
 87:21 199:6  
**requires** 124:16  
**requiring** 88:9  
**research** 26:18  
 114:3 225:1,2,4  
 239:22

**residence** 185:21 144:13,22,23,25  
**residue** 69:16 136:3 145:4 148:7 150:14  
 140:19,25 155:11 156:7,14  
 141:3,5,16,21 157:5 158:1  
 142:2,9,15,20 159:4,14,15  
 143:18 145:24 160:1 170:10  
 146:2,21 147:13,15 171:15 175:23  
 148:1 149:6,20 176:6 177:24 178:3  
 150:12 151:24 208:19 224:21  
 152:17,19 155:24 **responses** 3:8 142:7  
 159:7 160:16 144:2,3 145:25  
 161:10 165:21 146:18 148:5 154:8  
 174:22 175:8 158:10 159:18,25  
 177:24 178:3,8 **responsibilities**  
**residues** 61:22 241:1  
 150:14 172:25 **responsible** 132:7  
 173:16 177:17 **rest** 129:14  
 227:25 231:14 134:22 188:14  
 242:20 **restricted** 5:19  
**resolution** 82:21 **result** 7:1 89:14  
 122:4,8 124:8 **resulting** 6:13  
 223:5 136:12  
**resolve** 138:5 **results** 6:3,16 16:2  
**resolved** 82:25 32:3 35:23 72:12  
**resonance** 178:18 82:21 131:16  
**resorption** 13:4 161:19 182:5 191:7  
**resources** 51:24 193:3,7 194:7  
 224:25 225:1 **resume** 216:5  
 234:25 **resuspended** 43:23  
**respect** 25:9 40:3 **resuspends** 39:20  
 64:20 82:11,21 **resuspension**  
 83:18 136:16 28:17,22 29:23  
 172:15 185:21 30:18 39:10 41:4  
 231:7,21 233:24 **retention** 76:16  
 234:24 **return** 25:4  
**respected** 126:19 230:16,21  
**respiration** 58:21 **Revick** 195:18  
 100:5 **review** 133:22  
**respiratory** 54:5 203:25  
 55:18 101:1 **reviews** 159:20  
**respond** 154:3 **revised** 3:23 173:12  
 171:13 239:19 **Revision** 2:10  
**responding** 142:21 **revisions** 73:14  
 153:23 **revisit** 138:8  
**response** 4:20,21 **revisited** 56:21  
 84:15 142:11 **revisiting** 202:24  
 143:25 **revoked** 101:24

**re-volutilization**  
 188:24,25  
**Riard** 62:5  
**Rica** 193:21  
**rice** 207:12 208:9  
**Richard** 226:2  
**ring** 166:13  
**ripple** 131:8  
**risk** 2:11,23  
 5:13,18 7:14,18  
 46:14 47:9,18  
 60:16  
 61:7,11,12,17  
 83:20 90:3  
 109:10,11 110:9  
 126:23 131:1  
 133:20 135:19,23  
 139:15 167:15  
 179:23 199:2 207:1  
 216:17,21 220:20  
 227:1,3  
 231:23,24  
 232:1,5,13,15  
 233:11,13,22  
 234:3,12,21  
 235:13,17,23  
 236:24 237:14  
 243:1,5  
**risks** 89:13  
 133:14 217:2,5  
 233:18  
**river** 29:16  
 43:10,11 87:11  
 183:22 188:12  
 211:18  
**riverine** 212:1,9  
**rivers** 29:15  
 30:19 212:5  
**road** 52:5 104:19  
**Rockies** 183:9  
**rodents** 81:7  
**Roger** 199:21  
**role** 206:15  
**room** 132:12 208:10  
**root** 92:17 93:18  
 94:25 95:4,5 110:1  
 116:3

**roots** 94:15 114:1  
 115:19 125:19  
**Ross** 62:4 63:20  
 90:19  
**rough** 106:16  
**roughly** 95:3 112:14  
 139:2 147:19 189:2  
**round** 25:3  
**route** 74:21  
 152:8,16  
**routed** 37:16  
**routes** 47:5,8,12  
 140:9 141:2 142:24  
**routine** 207:25  
**routinely** 5:12  
 89:20  
**routines** 207:24  
**row** 7:8  
**rub** 9:18  
**rubs** 9:18  
**rule** 78:1 105:12  
**rules** 112:15,22  
**ruling** 101:19  
**run** 12:10 30:15  
 35:22 45:7 77:8  
 100:7 145:8  
 149:1 192:22 213:3  
 217:10  
**running** 194:14  
**runoff** 38:6,25  
 59:11 200:20  
 227:22 229:5  
 230:25  
**runs** 134:21 150:21  
**ruse-based** 40:22  
**rush** 89:3 138:16

---

S

---

**safe** 43:9 156:4  
**salmon** 158:24  
**same...by** 24:2  
**same...the** 24:1  
**sample** 20:17 193:25  
**samplers** 193:20  
 209:21,22  
**samples** 21:18

194:14 209:20  
**sampling**  
 197:16,20,23  
**San** 213:6  
**sand** 41:17 45:19  
**sap** 114:8 131:11  
 133:16 136:11  
 141:2 204:1 207:20  
**Sappington** 18:19  
 21:5 25:12 26:4  
 71:3,4 84:18,19  
 173:8 177:20  
 178:19  
**satisfied** 126:1  
**saturate** 24:22  
**save** 141:25  
**saw** 6:11 9:18 29:22  
 52:18 82:23 116:16  
 122:20 230:15  
**scale** 56:2 83:24  
 107:8,14  
 123:2,21 124:2,4  
 125:12 126:3  
 127:25 128:2  
 130:25  
 137:3,14,23,25  
 138:3 181:15  
 183:20 191:15  
 193:8 194:25  
 197:21,22 225:24  
 232:23  
**scales** 107:11 202:8  
 203:18 223:19  
 226:17,18  
**scare** 236:2  
**scattered** 120:6  
**scavenging** 195:22  
**scenario** 6:23  
 7:5,15 82:13 84:11  
 91:9 93:7 99:8  
 103:21 109:15,16  
 121:5 129:16 224:1  
 227:24 228:22  
**scenarios** 6:5  
 7:5,17 93:6 129:18  
 137:5  
 227:10,14,17,19

228:4,7 230:15  
**schedule** 89:1  
**scheme** 204:20  
**Schlenk** 48:12  
 72:19,20 77:3  
 141:12 164:1,2  
 176:12,13  
**Schlenk's** 168:18  
 177:15  
**science** 2:22 5:19  
 90:4 101:22 116:13  
 139:13 212:21  
 231:20  
 234:20,21,23 235:1  
 239:22  
**scientific** 2:1,18  
 3:11 235:7 240:11  
**scientifically**  
 33:16  
**scientists** 84:15  
**scratch** 40:24  
 63:5 127:19  
**scratches** 168:17  
**screen** 180:1 187:12  
 219:22  
**screening** 5:12  
 98:18 108:15  
 119:19 120:20  
 123:6 179:20  
 180:6,8 192:5  
 193:12 198:16  
 214:22  
**se** 75:4  
**sea** 183:13 184:4  
 187:24  
**seals** 63:22,25 64:2  
**season** 124:6  
**seasonal** 86:1  
 134:20  
**seasonally** 135:5  
**second** 8:24 22:15  
 50:12,22 93:9  
 104:5 110:19  
 113:15 116:8  
 117:18 124:1  
 132:13 146:4  
 184:20 211:1

226:23 236:4  
**secondary** 242:1  
**section** 141:15  
 225:16 226:5  
**security** 81:20  
**sediment** 6:17 7:1,2  
 13:3 22:22 23:19  
 27:25  
 28:6,8,10,18,25  
 34:18 37:24 40:7  
 42:9,10 48:24  
 97:11 126:5 142:18  
 143:16 145:16,17  
 146:16,17,18,22  
 147:11 192:14  
 221:4 226:19  
 230:24  
**sediment/water** 31:4  
**sedimentation**  
 6:22 28:22  
 29:15,16  
**sediments** 23:14  
 27:19  
 43:9,11,13,18,22  
 45:11 58:3  
 72:12,15 188:1  
 195:15 209:1  
 211:10 226:10,13  
**seed** 133:10,15  
**seeds** 117:14  
**seeing** 44:6 74:3,10  
 75:1 76:9 166:6  
 179:11 215:1 240:2  
**seek** 175:20  
**seem** 28:1 72:25  
 73:2 87:13,14  
 110:16 115:6  
 123:18 158:22  
 168:23 176:3  
 217:15  
**seemed** 73:6  
**seems** 14:15  
 28:19,21 63:7  
 72:13 87:23 108:10  
 114:7 123:4  
 137:13,22 147:11  
 169:4 207:7  
 224:3 227:24  
 230:21  
**seen** 74:13 75:16  
 152:24 158:16,19  
 197:25 214:5  
 235:1,15 241:8  
**seldom** 80:23  
**select** 41:4  
**selected** 2:10,23  
 134:13 139:14  
 173:25  
**selecting...it's**  
 41:3  
**selection** 219:18  
**selective** 114:9  
 134:15  
**selenium** 164:7  
 165:17  
**selling** 241:2  
**semi-static** 7:10  
**send** 206:7  
**sending** 210:17  
**sends** 182:9  
**sense** 74:6 89:7  
 108:13,17,19  
 123:24 127:25  
 137:17 168:16  
 174:25 195:12  
 220:10  
**sensitive** 6:14  
 28:19  
**sensitivity**  
 104:15 146:8,24  
 160:9 172:15  
 214:24  
**separate** 14:10  
 21:17 25:17 31:2  
 109:20  
**separated** 235:14  
**separately** 38:15  
**separation** 233:12  
**sequestration** 155:3  
**series** 15:14 104:23  
 217:11,15 230:25  
**seriousness** 181:7  
**Service** 225:1,2,3,4  
**session** 139:12  
 243:13  
**sessions** 133:17  
**sets** 95:12 193:19  
 197:14  
**setting** 35:9 167:19  
**settling** 34:22,25  
 39:10  
 45:7,10,14,15,17,1  
 8 46:2 212:16  
**seven** 179:17,20  
 215:20  
**seventy** 192:11  
**several** 49:21  
 51:7 58:2,13 67:23  
 71:10 82:4  
 113:22 143:15  
 153:12 162:19  
 183:10 184:24  
 189:9  
**sex** 236:12  
**shape** 6:9 23:11  
**shaped** 10:4 102:22  
**shared** 120:17  
**shed** 209:23  
**sheds** 239:18  
**sheer** 42:8 212:20  
**Sherringer's** 211:6  
**Shes** 114:4  
**shift** 83:20  
 218:11 231:23,24  
**shifting** 63:3  
 232:16  
**shifts** 122:17  
**short** 22:10 28:24  
 29:7 33:15 48:16  
 98:7 110:20  
 118:6 119:22 121:4  
 137:10 159:13,16  
 172:5 175:4  
 182:4 208:25  
 219:24 224:12  
 231:6 234:6  
**shorter** 147:21  
**shortly** 233:16  
**short-range** 109:16

**short-term** 5:8 222:20 223:25 30:8 40:21 75:21  
 9:7 12:24 33:6 237:18 **six** 14:4 156:13  
**shot** 219:23 **simple...I'll** 62:23 172:2 192:13  
**showed** **simple...relatively** **sixty-three** 185:17  
 80:12,13,19 102:17 127:16 **size** 41:24 55:25  
 222:12 **simplify** 94:19 95:7 74:18,22 76:1,10  
**showing** 36:19 127:11 213:5 105:22 164:18  
 76:7 147:17 **simplifying** 99:5 242:2  
**shown** 79:13 81:17 **simplistic** 114:16 **sizes** 27:19 56:3  
 102:22 115:4 116:1 **simply** 26:2 54:12 74:23  
 169:6 56:9,22 78:25 **size-specific** 113:4  
**shows** 58:14 103:6 79:18 100:24 103:1 **sleeping** 208:3  
 107:25 113:23 112:6 118:22 182:1 **sleeve's** 160:6  
 128:24 163:1 208:9 185:13,20 186:5,13 **slide** 18:15  
**shrew** 162:15 196:7 198:13 199:8 48:14,20 52:8,20  
**Sierras** 183:9 200:15 202:4 53:10 55:2 56:25  
**significant** 22:3 **simulate** 14:9 29:22 60:5 61:25 63:6  
 59:8,24 68:18 74:4 30:8,17 64:15 90:25  
 76:16 87:23 **simulated** 38:14 116:9,10 142:4,7  
 91:17 94:25 101:15 **simulating** 30:11 147:17 149:4  
 118:1 191:23 212:5 **simulation** 57:19 151:15 152:20  
**silt** 41:17 45:18 **simulation** 58:2,11 154:21 159:5  
**similar** 47:13 62:20 **simultaneously** 217:15 219:14  
 77:9 78:13 81:9 197:16 220:12,21 222:13  
 88:15 102:20 **single** 55:10 **slides** 141:22 220:4  
 103:11 121:11 60:21 145:10 **slightly** 100:14  
 134:12 147:22 167:11 188:15,16 112:15 121:15  
 162:6 175:1 209:20 237:18 **slip** 222:12  
 191:7 194:11 214:6 **sink** 229:6 **slopes** 69:20  
 241:11,12 **sister** 241:9 **slow** 78:15  
**similarities** 166:20 **sit** 199:14 209:22 **slower** 183:20  
**similarly** 186:3 **site** 72:15 79:19 **small** 31:24 55:12  
**Simon** 169:14 99:9 128:14 143:11 78:14 79:7 95:12  
**Simonich** 49:21 152:12 176:25 115:15 128:14  
 140:1 180:20 194:1 200:18 157:13 178:16  
 204:12,13 210:4 **sites** 89:21 143:6 **smaller** 19:18 21:12  
 213:8,9 197:18 231:21 233:3,4  
**simple** 35:7 61:7,12 **sitting** 33:12 130:6 **smart** 205:18  
 82:13 84:10,11 135:13 207:9 **smelling** 240:22  
 85:15 96:24 220:22,23 **snails** 153:24  
 104:12,16 117:24 232:6,7 234:4 **snow** 183:13  
 118:13 127:17 **situation** 7:1 **So...and** 29:3  
 132:21 136:16 44:2 79:24 80:4 45:9 121:11  
 145:19 150:5 91:9 100:8 136:7 **So...but** 115:21  
 157:20 197:1 167:15 201:13 **So...I** 29:17  
 198:16 200:11 212:7 228:18 **so...so** 8:14 61:1  
 205:22 219:24 **situations** 6:24 7:5 63:3 114:9 127:14

**so-called** 99:1  
**social** 235:11,19  
 238:2  
**socially** 236:2  
**socks** 240:20,21  
**software** 11:11  
**soil** 7:2 12:24  
 23:12  
 40:17,18,23  
 41:16,22 91:16  
 97:8,12 102:3  
 106:10,12  
 116:21,23 118:15  
 126:5 185:3,5  
 188:1 192:11,19  
 200:23,24  
 201:9,10,11  
 202:6,12,14  
 203:1,18 205:2  
 214:16 225:14  
 228:10,18,24  
 229:23,25 230:10  
 243:3  
**soil/plant** 90:23  
**soils** 13:5 23:16  
 117:10 203:16  
**solid** 9:4 13:12  
 15:5 23:5,25 72:10  
 74:1  
**solid...solid**  
 120:18  
**solids** 37:24  
 38:12,13  
**solubilities** 96:2  
**solubility** 64:16  
**solubility** 8:7,11  
 9:25 15:17,19,23  
 16:12  
 17:2,14,23,24  
 18:3,7,16,21,25  
 19:5,23  
 20:5,15,20,25  
 22:1,10,14,24 23:7  
 25:10 56:17  
 64:19,23 67:8  
 78:13 79:6 82:22  
 238:7  
**soluble** 23:16 78:21  
 94:14 109:23  
**solution** 20:16,23  
 224:9  
**solve** 146:14  
**solvent** 19:14,17,20  
**some...some** 95:13  
 120:2  
**some...with** 112:22  
**somebody** 45:14  
 205:17  
**somehow** 162:9  
 205:23  
**someone** 3:4 198:4  
 229:8  
**somewhat** 31:7 81:10  
 103:10 126:14  
 194:11  
**somewhere**  
 53:20,24 54:16  
 79:2 208:4  
**sooner** 24:3,5  
**sophisticated** 92:24  
 98:22 110:17  
 185:10 198:20  
 211:20  
**sophistication**  
 107:15 185:11  
 191:25  
**sorbed** 17:16  
 33:21 34:2 37:15  
 196:2,24 199:13  
 212:12  
**sorbition** 27:17  
**sorption** 17:2 34:12  
 211:9,10  
**sorption...the**  
 16:21  
**sorry** 8:5 18:10  
 24:17 37:5 99:25  
 129:6 168:11 187:8  
 214:12 224:10  
**sort** 3:19 5:8,11  
 19:14,17 25:5  
 29:11,14  
 33:15,17 39:11  
 40:19 50:3  
 60:9,21,22 62:20  
 73:14 75:8,10,20  
 76:24 77:23  
 78:19 80:5,21 81:7  
 82:3 83:24 85:1  
 86:12 90:21  
 91:6,21 92:3 93:12  
 99:1,16 102:14  
 103:4 105:2 112:25  
 116:17 117:19,24  
 119:20 129:19,20  
 138:15 140:2 143:9  
 151:10 154:19  
 160:14 162:13  
 163:8,11,22 165:10  
 167:4 169:18  
 170:1,15 172:19  
 173:4 174:24  
 175:3,6,9 177:3  
 229:16 234:2  
 237:22 243:23  
**sorts** 34:17 109:8  
 110:7 115:7  
**sound** 52:23 57:4  
 63:9 172:5  
**sounds** 46:1  
**source** 59:8  
 181:16 185:25  
 197:17 200:13  
 201:16,17,18,21  
 210:1,2,4,6,10  
 226:22  
**sources** 210:8  
**South** 210:15  
**southeastern** 182:15  
**southern** 85:24  
 181:17 194:15  
 210:17  
**space** 122:11 141:25  
 143:13,19  
 186:14,17,25  
 235:14  
**spatial** 107:8,11  
 122:5,8 123:2,21  
 130:25  
 137:2,8,14,23  
 138:3 223:18

225:23 226:17  
**spatially** 83:21  
 231:24  
**spawning** 76:15  
 134:20  
**speak** 171:7  
**speaking** 212:13  
**special** 81:2  
 133:7 199:5  
**species** 58:2  
 59:17 62:24  
 63:3,19 77:13  
 81:11 86:6,7,12  
 87:15 94:9  
 105:22 115:8,11,21  
 117:6,22 118:23  
 121:9 131:2 142:14  
 143:5 146:6,7,8,24  
 148:2,9,23  
 149:18,23  
 157:12,13 160:11  
 162:7 172:15  
**specific** 34:14  
 35:11 46:6 93:6  
 99:3 114:7  
 125:20,21 126:8  
 132:6 134:23 145:2  
 155:4,10,19 157:24  
 159:9 160:3,10  
 166:9 167:9 170:11  
 173:19 174:15  
 176:8 177:18,21  
 178:18,25 201:13  
 212:25  
**specific...I** 76:12  
**specifically**  
 92:21 93:14 160:12  
 167:24 178:19  
 200:4 209:1 216:22  
 228:18  
**specified** 177:21  
**specifies** 179:2  
**specify** 168:4  
 177:18  
**speed** 34:25  
**spell** 141:24  
**spent** 116:10  
**spiders** 236:25  
**split** 99:16 165:8  
 174:23 216:8  
**splitting** 238:24  
**spoken** 44:11  
**spray** 19:6,7  
 37:14 38:15,19  
 117:4 200:18 201:8  
 207:17  
**spraying** 207:10  
**spread** 210:9  
**spring** 77:14  
**SSD** 146:8 147:1  
 148:15,19,22  
**stab** 29:8  
**stabilizer** 80:10  
**Staci** 180:20 210:2  
**staff** 3:12 139:21  
**stage** 66:15  
 76:13,22 107:17  
 135:6  
**stages** 59:22 175:6  
**stand** 102:12  
**standard** 27:11  
 56:20 82:14  
 86:13 120:3 129:20  
 140:13 144:22  
 148:13,14 150:5,18  
 153:7 234:3,12  
**standpoint** 100:4  
 129:12 229:20  
**stark** 60:9  
**start** 2:5 14:14  
 16:25 18:2 48:9  
 53:19,23 60:6  
 62:17 82:3 88:5  
 99:12 104:25  
 115:13 119:15  
 120:4 137:9  
 139:7 149:1,2  
 156:11 160:12  
 161:24 168:17  
 176:18 202:15  
 204:19 206:8 235:5  
 239:5 243:15  
**started** 91:5 210:12  
 224:20 235:24  
**starting** 14:21  
 41:16 52:4 62:20  
 63:4,12 85:3 120:2  
 151:2 155:25  
 171:19 238:22  
**starts** 16:4,5 17:15  
 137:15  
**state** 27:22,23  
 49:12 55:20  
 56:19,21 60:23  
 65:10 67:21,23  
 68:6 77:16 84:7  
 85:25 90:4 94:2  
 95:8 98:1,2  
 106:6,18,25  
 107:2,24 115:18  
 116:13 120:11  
 127:17 131:7 159:6  
 185:21 190:19,22  
 192:6 196:2  
**stated** 51:17  
 80:15 202:3 232:21  
**statement** 200:5  
 242:7  
**States** 118:25  
 182:15 210:18  
 225:2  
**static** 7:10  
 39:8,11,14,24  
 40:10 79:23  
 229:6,15  
**static...does** 39:24  
**static...for** 39:14  
**static...our** 39:11  
**stating** 160:23  
**Station** 114:4  
**statistical**  
 145:25 221:23  
**stay** 92:22 139:2  
 188:10 200:21  
**stays** 78:24  
**steady** 55:20  
 56:19,21 60:23  
 65:10 67:21,23  
 68:6 77:15 84:7  
 98:1,2 106:6,18,25  
 107:24 127:17

185:20 190:22	41:14 226:10	<b>sub-discipline</b>
192:6	<b>strength</b> 82:5	142:1
<b>steady...time</b> 67:23	142:23 147:25	<b>sub-group</b> 141:11
<b>Steenhuis</b>	152:15	<b>subject</b> 56:9
28:13,14 29:20	<b>strengths</b> 47:19	83:19,22 232:3
30:20 180:21	90:6 140:24	<b>sublethal</b> 158:8
206:11,13	141:4 142:8 145:14	159:17
<b>step</b> 44:14 55:11	151:23 152:1,2	<b>sub-lethal</b> 144:3
67:5 145:8 150:2	164:10,20 180:7	159:14,19,24
157:25 168:1,3	<b>stress</b> 42:8 213:10	<b>submit</b> 4:12 78:19
185:7 200:14	<b>stressors</b> 225:18	<b>submitted</b> 139:24
202:10 218:18	236:15	140:13 180:13
220:7 234:17	<b>Strickland</b> 226:1	<b>sub-panel</b> 133:5
<b>Stephan</b> 93:3 120:19	<b>strict</b> 15:5	180:20
<b>steps</b> 218:3	<b>strong</b> 44:18	<b>sub-question</b> 39:6
<b>Steve</b> 2:17	67:20 147:14	<b>sub-questions</b> 33:17
<b>Steve's</b> 233:11	154:11	<b>substances</b> 173:1
<b>Stewart</b> 3:19	<b>stronger</b> 86:1	<b>substantial</b> 47:8
<b>stick</b> 9:8,9	<b>strongly</b> 196:24	63:4 113:25 194:20
10:4,5 13:19,23	<b>structure</b> 5:12 53:7	<b>substantially</b> 39:22
14:2,7,20 16:25	62:21 82:21 112:15	56:10,12 60:24
17:6 22:16	136:17 166:20	61:9,13 162:20
23:9,10,20 24:21	214:6	<b>subtle</b> 236:14
28:20 85:18 119:15	<b>structures</b> 57:11	<b>sub-unit</b> 117:18
138:21 202:4	<b>student</b> 62:4	<b>sub-units</b> 116:20
<b>stirred</b> 41:12	67:24 102:17	<b>suburban</b> 208:7
<b>stop</b> 168:2,3	<b>students</b> 187:11	<b>such...is</b> 51:18
<b>storage</b> 79:19	<b>studied</b> 80:8 100:19	<b>such...such</b> 54:14
135:2,4,5 165:4	<b>studies</b> 19:9,18	<b>sudden</b> 43:22
<b>stores</b> 161:19	51:4,10,11,19	<b>suddenly</b> 27:25
177:15	52:10 71:9 76:11	<b>sufficient</b> 56:18
<b>storm</b> 39:20 43:18	81:18 87:2	67:14 117:23
<b>storms</b> 39:19	103:11 136:1	127:20 152:7 154:9
<b>stragglings</b> 5:16	140:13,17 143:23	<b>sufficiently</b> 201:4
<b>straight</b> 210:15	147:17 150:11	<b>suggest</b> 53:18 95:12
<b>straightforward</b>	152:1 167:8	178:10
86:11	169:6 172:10	<b>suggesting</b> 53:24
<b>strange</b> 131:19	182:13,22 183:5,14	125:23,24 203:12
207:7	191:6 196:23	<b>suggestion</b> 36:13
<b>strategies</b> 222:11	214:16,17	44:14
<b>strategy</b> 51:15 52:9	<b>stuff</b> 27:20 28:5	<b>suggestions</b> 49:21
<b>stratifying</b> 175:7	82:22 110:8	84:20 122:25 123:1
<b>stream</b> 7:25 12:25	125:3 126:3 136:19	220:1,24 221:1
39:17 93:15	172:16 207:16	<b>suggests</b> 8:20 88:1
137:20,21 200:20	<b>sub</b> 207:24	<b>suitable</b> 112:19
219:4	<b>sub...substantial</b>	<b>suited</b> 90:15,22
<b>streams</b> 31:16 40:15	59:12	

92:18	<b>surfaces</b> 55:19	236:21
<b>summarization</b> 72:21	107:12,13 115:16	
<b>summarize</b> 87:19	120:25	T
141:10	<b>surfactant</b> 22:8	<b>table</b> 4:2 68:10
<b>summarized</b> 50:24	<b>surprise</b> 222:4	92:25 98:17 218:17
191:6	<b>surprised</b> 123:14	<b>tables</b> 3:21
<b>summarizing</b> 66:2	162:6	<b>tadpole</b> 59:22
70:8 72:2 235:7	<b>surprises</b> 132:19,23	<b>taking</b> 30:9,10,25
<b>summary</b> 18:14	239:7	51:1 90:15
180:22 204:14	<b>surprising</b> 131:15	102:12 131:4
237:22	222:4	<b>taking...</b>
<b>summer</b> 72:10	<b>surrogate</b> 81:19	<b>essentially</b> 30:25
<b>super-enhanced</b>	149:17 171:21	<b>talk</b> 29:3 30:17
22:13	<b>surrogates</b> 96:2	31:3 60:5 61:23
<b>Superfund</b> 72:7	112:11	62:9 92:21 111:4
136:17 231:21	<b>survey</b> 32:2	151:22 226:3
<b>super-hydrophobic</b>	<b>surveyed</b> 26:5	235:10
54:12 77:22,25	<b>suspect</b> 13:22 41:7	<b>talked</b> 78:6 84:23
<b>supplement</b> 142:6	<b>suspected</b> 131:20	93:17 98:6 121:8
<b>supply</b> 130:16	184:10	130:12 137:20
<b>support</b> 37:1	<b>suspended</b> 188:19	146:5 164:22 208:3
<b>supported</b> 171:9	<b>suspension</b> 45:6	220:4 238:6
<b>suppose</b> 33:25	<b>swallows</b> 62:6	<b>talking</b> 3:14 4:18
<b>supposed</b> 109:8	<b>SWAT</b> 226:5	10:6 14:24,25 17:7
110:5 192:25	<b>sweet</b> 231:7	90:22 107:7,10
<b>supposedly</b>	<b>swimmers</b> 188:7,11	111:1,3,23
240:20,23	<b>Switch</b> 21:22 137:1	137:19,23,25 138:4
<b>sure</b> 4:13 6:18 8:19	<b>Switzerland</b> 211:7	145:1 153:3 176:21
11:25 13:19	<b>synergy</b> 196:12	180:25 182:3
14:24 18:11,19	<b>synonymous</b> 65:1	185:13 204:19
20:13 24:18	<b>synonyms</b> 65:10	206:25 207:8
25:5,19 42:22 46:9	<b>system</b> 7:12 9:11	214:19 218:13
48:12 68:22 92:7	24:23 30:17 32:4	235:10
100:7 103:16	59:16 91:12	<b>Tammo</b> 180:21
118:18 122:21	96:17 97:25	<b>target</b> 69:24
124:11 153:5	111:9,11 116:3	127:7 143:11
156:5,24 166:21,24	119:24 121:10	152:12 157:24
176:1 179:1	126:5 130:19	158:5 165:16,19
204:8,10 206:1	137:24 152:10	185:24 190:12
211:13 213:20	164:16 189:3	<b>targeting</b> 134:23
218:21 231:18	222:17 223:2,5	<b>tasked</b> 192:4
232:12 233:21	237:10	<b>taxa</b> 112:12 148:23
<b>Surei</b> 130:8	<b>systems</b> 7:24	<b>taxas</b> 148:25
<b>surface</b> 16:18	19:19 59:9 87:11	<b>taxa's</b> 160:3
113:21 185:23	95:23 106:7 111:16	<b>taxier</b> 160:8
192:10 201:9	118:7 137:25	<b>taxonomic</b> 111:15
213:12		<b>taxonomically</b> 81:7

**TBT** 153:22  
**team** 215:22  
 240:10 241:14  
**tease** 56:5  
**technical** 69:10  
**technique** 24:2 38:1  
 224:4  
**techniques** 25:19,20  
 189:10 224:11  
 225:12  
**technology** 44:23  
**temperate** 183:4,25  
**temperature** 19:23  
 49:15  
 58:8,12,15,20 59:2  
 85:21 86:1 103:1  
 151:8 190:21,23  
 192:22  
**temperature-**  
**dependent** 58:24  
**temperatures** 236:16  
**template** 41:23  
**temporal** 49:10  
 60:11 122:5,8  
 124:1 130:25  
 137:3,9,14,24  
 138:3 162:8,25  
 223:19 225:24  
 226:18 233:12  
 237:20  
**temporally** 83:20  
 84:3 135:6 232:1  
**temporarily** 39:18  
**ten** 77:4 142:22  
 158:8 159:22 160:1  
 166:5 176:4 192:11  
 198:25 209:9 216:2  
 217:15 221:12  
 225:8 227:21 228:9  
 232:7 234:13  
 237:24 243:10,20  
**tend** 15:16,23  
 59:4 73:11  
 102:25 177:5  
 187:22 188:18  
 205:7 229:15  
**tended** 190:2  
**tends** 17:17 94:6  
 100:24 137:7  
**tens** 43:19  
**tentatively** 215:25  
**tenths** 208:5  
**term** 29:4,7 33:15  
 65:9 82:17 83:11  
 112:3 121:4,5  
 129:4,22 145:24  
 147:21 154:20  
 155:8 157:8  
 158:7 159:13,16  
 171:21 172:5  
 175:4,5,11  
 191:17 224:12,13  
 225:9 226:13  
 236:15  
**terminology** 98:6  
**terms** 5:7 14:18  
 22:1,13 33:6 39:13  
 46:13 60:22  
 66:23  
 73:3,14,19,20,21  
 74:19,23  
 75:7,12,25  
 76:2,3,5,7,10,16,1  
 7,21,22,25 85:12  
 86:22 88:25 102:16  
 109:5,9 110:8  
 112:2 115:5  
 119:16,25 120:11  
 121:9 130:16  
 131:22 161:8  
 163:12  
 164:7,9,10 165:2  
 166:3,17,25 167:18  
 176:19,23 177:10  
 188:5 222:19  
 233:16 239:9,25  
**terrest...the**  
 122:15  
**terrestrial** 59:23  
 80:8 81:4,6,19  
 86:19 88:6  
 89:13,21,23 90:2,5  
 93:8 95:20,23  
 96:17 98:9  
 100:13 103:19,24  
 109:9 110:9,16  
 111:12,16,24 118:5  
 119:6  
 122:3,15,23  
 123:3 127:3,7  
 129:19 134:6  
 135:17 136:16  
 137:24,25 138:5  
 165:6 216:17  
 227:24 229:21,22  
 236:21 242:20  
 243:1,5  
**Terry** 204:19  
 205:6 209:12  
**test** 8:8 67:3 69:13  
 70:23 71:5 87:22  
 140:13 178:11,21  
 197:15 198:3  
**tested** 153:13 154:3  
 225:17  
**testing** 73:23  
 153:19 160:21  
 167:6,9  
**tests** 51:7  
 55:6,17,23 56:18  
 71:1 141:7  
 152:18 173:23  
**than...at** 109:4  
**than...we've** 56:10  
**thank** 2:8 3:18 4:15  
 12:10,11 26:25  
 28:12 30:20 39:3  
 44:7 46:10,24 48:5  
 65:20 70:4,5 71:23  
 72:18,21 77:3  
 81:22 84:13,19  
 88:12 95:18  
 104:6 113:14 129:8  
 132:25 134:1 141:8  
 157:8 161:2,5  
 163:18 168:6 171:6  
 180:18 203:22,24  
 205:4 209:6  
 215:5,8,22  
 217:8,17 223:13  
 231:4 235:3,5  
 238:1 242:11,14

<b>thank...to</b> 2:8	46:15 51:12 58:4	<b>the....what</b> 209:24
<b>thanks</b> 8:4 77:19	59:10 64:7	<b>the...all</b> 40:7
81:21 104:9 110:22	65:5,18,19	<b>the...at</b> 102:7
113:13 131:13	68:11,13 70:3,19	<b>the...both</b> 13:4
132:24 163:20	71:14 75:6,23	<b>the...can</b> 90:24
171:5	76:18,20,23 77:2	<b>the...feedback...</b>
<b>that...I</b> 76:18,19	78:22 81:2,21	I 113:18
<b>that...in</b> 16:7	83:9,15,21 88:1	<b>the...for</b> 109:24
100:12	93:1,21 94:1,7	<b>the...from</b> 9:19
<b>that...is</b> 54:8	95:8,15 96:20	<b>the...I'm</b> 108:25
<b>that...taking</b> 44:5	99:7,8,14 100:19	<b>the...in</b> 14:7 27:23
<b>that...that</b> 11:22	101:20 102:12	30:10 81:6 90:14
19:22 22:23 23:5	105:14 106:23	96:15 117:12
40:21 48:16 49:3,7	108:11 109:10	122:20
52:3 53:5 56:22	111:5 112:4,8,17	<b>the...into</b> 33:22
57:9,12 58:9,14	117:1 120:13,22	<b>the...just</b> 97:2
59:1 62:7,11 63:13	121:3,11,22	<b>the...on</b> 77:23
66:5 90:10 91:24	123:12,16 125:4	<b>the...that</b> 44:15
92:6 97:18	127:2 128:19 129:7	49:23
100:9,13 101:20	138:22	<b>the...the</b> 14:18
103:15 108:7	142:19,24,25	17:1,12 22:4,12,15
114:17 118:24	143:13 145:5,24	23:10 32:13
119:18 122:13	146:8 147:20	33:19 37:15
123:7 129:18	148:11,18 149:19	43:14 50:1,25 51:2
132:10	150:15 152:12	52:7 53:8 54:25
<b>that...that...</b>	154:6,19 155:11	56:15 59:19 61:2,8
<b>such</b> 60:4	156:25 157:25	63:14 66:25 73:7
<b>that...that...</b>	158:5 159:7,17	74:1,15 76:2
<b>that</b> 32:10 130:5	160:19,25 163:24	77:8 90:22 91:9
<b>that...that's</b>	165:10 166:25	92:18 93:17
92:4 129:19	167:15 170:8	94:5,8,25 99:20
<b>that...the</b> 62:25	171:24 172:11,16	100:23 102:15
<b>that...there</b> 64:18	173:10 176:18,22	107:15
<b>that...to</b> 117:21	177:25 186:19	109:1,12,19,21
<b>that...under</b> 33:18	189:7 195:22 196:7	110:6,16 112:14
<b>that...well</b> 10:21	197:19 200:14	114:2 116:2 117:16
228:4	204:4,6 208:22	119:3,23
<b>that's</b> 4:9 6:18 8:8	209:3 213:21,23	120:9,16,21
10:16 12:9,21,22	218:2,21 219:19	121:5 122:18 124:3
13:10,13,20	220:6 222:5 223:10	126:11 128:8 133:7
14:16,17 16:7,22	225:22 227:20	135:3,15 137:2
18:3 19:11,21	228:6,17 229:13	<b>the...the...it</b>
21:16 22:12	232:10 233:22	17:15
23:23 24:23,25	234:22 235:13	<b>the...the...that</b>
26:24 29:19	240:3 243:1,6,24	35:9
30:21 36:14	<b>that's...that's</b>	<b>the...the...the</b>
38:11 40:22 43:3	13:11 50:8 85:6	125:25
	105:3	

<b>the...the...the...</b>	51:3,6 52:2 54:2	<b>they...their</b>	190:11
<b>essentially</b>	17:1	<b>they...they</b>	30:3
<b>the...then</b>	121:10		50:3 52:10 58:25
<b>the...there's</b>	11:21		97:5 99:19
<b>the...these</b>	91:24	<b>they'd</b>	5:1
<b>the...to</b>	34:3 37:18	<b>they'll</b>	48:12
<b>the...well</b>	21:8		188:20
<b>the...what</b>	76:7	<b>they're</b>	5:1 12:17
<b>The...which</b>	8:6		13:7,20 24:8,9
<b>the...with</b>	40:10		25:21 36:10
	86:19		38:14 41:13 54:4
<b>the...yeah</b>	27:23		61:9 66:16,19
<b>The...yes</b>	130:21		78:13 84:21 86:8
<b>the...you</b>	21:13		94:8 98:21,24
	96:10		102:4,11 103:1
<b>their...their</b>	86:22		107:5 111:19 114:9
<b>themselves</b>	3:2		116:4 118:19
	174:4		122:16 123:19,23
<b>then...then</b>	91:16		132:4 134:23
<b>theoretical</b>	24:24		138:18 144:8,9
<b>theoretically</b>			155:1 156:5 158:18
	13:23,24 23:23		163:5 169:24
	130:18		170:21,23
<b>theories</b>	202:24		173:13,14 182:1
<b>theory</b>	40:23		187:24 188:8,15,21
<b>there...and</b>	119:4		189:4 191:20
<b>there...if</b>	56:11		196:25 199:12
<b>there...it's...so</b>			209:19,20,23
	111:24		211:11 220:9 222:4
<b>there...that</b>	86:11		225:23 226:4,12,20
<b>there...there</b>	49:21		232:3 233:8 236:10
	54:3 97:10	<b>they're...they...</b>	
<b>there...there's</b>		<b>they</b>	96:1
	20:7 88:8 117:15	<b>they're...</b>	
<b>thereafter</b>	233:16	<b>they're...the</b>	54:5
<b>therefore</b>	7:2	<b>they've</b>	61:7
	35:6 79:16 96:20		95:11 159:21
	103:3 140:16		162:17 189:10
<b>there's</b>	3:21		211:9
	6:6,8 13:7	<b>Thibodeaux</b>	
	14:23,24 17:4 20:4		7:16,21,22
	21:8,24 24:11,20		8:4,13,14,17,23
	26:6,18		10:8,11,14,24
	27:11,19,20		11:2,6,14,17
	28:17 32:9 38:6		12:2,6,9,12,18
	41:21 43:2 46:6		13:15,21 14:13
			15:4,7 17:3
		<b>there's...I</b>	108:1
		<b>There's...my</b>	107:21
		<b>There's...obviously</b>	
			21:23
		<b>There's...that's</b>	
			8:16
		<b>there's...there's</b>	
			34:20 100:18
		<b>these...the</b>	75:17
		<b>these...these</b>	
			124:14 126:15

18:6,12  
 20:11,12,14  
 23:20 24:1,12  
 29:12  
 37:4,5,9,12  
 38:4,14,18,22 39:2  
 40:11,12 41:2,9  
 44:8 105:16,18  
 106:17,21,24  
 107:4,18 108:7  
 110:19 180:21  
 204:15,16  
 206:23,24 207:7  
**thickness** 31:7  
**things...and** 73:25  
**think...at** 138:9  
**think...or** 118:25  
**Thiolate** 158:17  
**third** 2:21 125:6  
 132:13 139:13  
**thirty** 158:21  
 192:12  
**thirty-seven** 185:19  
**this...is** 63:21  
 85:24  
**this...it's** 40:22  
**this...I've** 187:8  
**this...probably**  
 133:10  
**this...this** 118:9  
 123:5  
**thorough** 161:6  
**thoughts** 70:9  
 243:10  
**thousand** 192:13  
 193:13  
**thousand-fold**  
 159:24  
**threshold** 161:23  
**thresholds** 145:18  
**throat** 161:20  
**through...through**  
 57:19  
**throughout** 114:15  
 135:3 161:13  
**throw** 142:1 218:15  
**throwing** 44:6 159:3  
 207:16  
**thrown** 62:3  
**thyroid** 132:15  
 238:25  
**Tidal** 31:24  
**tie** 49:4 177:10  
**tier** 29:6,7,9,11,21  
 30:14,15,16,24  
 40:13 41:25  
 82:13 85:3 93:12  
 98:15 105:20  
 127:15,21,22  
 198:12  
**tiered** 5:11 61:4  
 66:24 67:5 72:24  
 73:18,22 82:11  
 84:23 87:18 88:9  
 165:9 198:11,21  
**tiers** 69:15  
**Tifton** 225:22  
**tighter** 148:19  
**Tim** 226:1  
**TIMS** 87:6  
**tissue** 61:21 128:22  
 140:19,25  
 141:3,5,16,19,20  
 142:2,9,15,20  
 143:8,10,12,18,24  
 145:20  
 146:10,12,15,21  
 147:13,15,22 148:1  
 149:6,15,20 150:12  
 151:24 152:4,17,19  
 155:24 156:4 159:6  
 160:15 161:10  
 162:8,11,22,25  
 163:9 171:4 172:25  
 173:15,19,25  
 174:22 175:7  
 176:15  
 177:3,4,20,25  
 178:18,25 179:1  
**tissues** 128:23  
 157:10,22 174:7  
 177:9,12 178:9  
**to...and** 57:24  
**to...and...and**  
 36:16  
**to...back** 91:18  
**to...I** 28:19  
**to...if** 42:19  
**to...like** 64:21  
**to...so** 14:6  
**to...the** 123:7  
**to...this** 34:11  
**to...to** 17:6  
 22:18 23:1 32:20  
 33:5,15 40:15  
 45:13 51:21 53:4  
 60:10,15 61:10  
 73:2,12 88:8  
 91:1 94:19  
 103:19 105:2 112:8  
 115:15 116:23  
 120:9 135:1 136:20  
**to...to...to** 41:20  
**to...to...to...**  
**and** 11:24  
**to...what's** 107:2  
**to...you** 73:11  
**TOC** 21:6  
**today** 4:13 25:6  
 89:2,5 185:13  
 215:25 242:14  
 243:11,17  
**today's** 2:9  
**tomorrow** 2:16  
 89:6 138:24  
 216:2,5,9 237:25  
 243:11,19 244:4  
**tons** 202:5  
**tool** 72:13 98:19  
 192:5 193:1,12  
 198:16 214:23  
**tools** 89:22  
 103:16 122:3,13,18  
 127:19 180:8 191:9  
 217:4 220:9,19  
 233:25 234:1  
**top** 31:12,13  
 43:14 44:5  
**topic** 2:23 3:19  
 43:1 48:11  
 136:22 139:14

181:6  
**topics** 138:18  
**Torton** 240:5,6  
 242:4,12  
**total** 20:21 38:11  
 206:14  
**totally** 27:24  
 164:10  
**touch** 66:4  
**touched** 118:7  
**tough** 28:11 73:12  
 156:25  
**towards** 66:24  
 68:5 73:22 77:15  
 78:17  
**tox** 19:9 127:10  
**toxic** 2:12,25  
 139:16 142:6,11  
 143:24 144:13  
 149:25 154:25  
 155:1,3,17 156:5  
 218:8  
**toxicant** 157:4  
**toxicity** 61:23 66:9  
 140:13,16,20,21  
 141:1,7  
 142:3,5,16,19  
 143:17,22  
 145:10,20 146:1,10  
 147:15 148:3  
 150:12 151:13  
 152:22 156:2,15  
 160:6,16,21  
 161:9 162:23  
 163:14 165:25  
 166:21 175:15  
 176:4 205:24  
 216:16 236:5  
**toxicokinetic**  
 143:2,5  
**toxicology** 123:24  
 194:13  
**toxics** 97:20 241:7  
**toxifene** 182:22  
 210:14,17,21  
**toyed** 76:3  
**toying** 11:19  
**TRA** 140:23 142:2  
 145:15  
**traces** 154:15  
**track** 6:3  
**tracking** 4:14 213:7  
**tracks** 60:11  
**tradewinds** 182:14  
**traditional** 132:10  
**traditionally**  
 47:1 105:4  
**tradvivores**  
 164:15,17  
**trajectories** 191:17  
 209:21 210:11  
**trajectory**  
 209:13,16 210:20  
**transfer** 48:25  
 67:1,4 70:23  
 71:5,6 78:15 79:16  
 87:22 97:22  
 106:8 108:20  
 125:19 134:25  
 185:22 192:8 215:7  
**transfer...or**  
 106:10  
**transfers** 78:23  
**transformation**  
 125:15 208:7  
**transit** 106:21  
**translate** 147:10  
**translating** 145:15  
**translocate** 114:1  
**translocated** 114:15  
**transpacific** 183:14  
**trans-Pacific** 182:8  
**transparency** 66:13  
**transparent** 66:22  
**transpiration** 93:15  
**transpired** 93:21  
**transpires** 93:24  
**transport** 65:12  
 83:19,22 91:25  
 96:14 97:4,22  
 106:10 107:1  
 109:2,16,18  
 114:7,11 121:5  
 123:6 125:6,14  
 128:7 132:15  
 136:8,13 137:13  
 179:17,20,22,24  
 180:1,7,9,24  
 181:1,11,15,18,21  
 182:4,5,13,17,24  
 183:14,17,23  
 184:3,7,12,15,24  
 185:2,9,15 186:9  
 188:12,13 189:6,23  
 190:10  
 191:10,16,22  
 192:2,7,21  
 193:18  
 194:3,7,10,18  
 198:3,10,12,18,21,  
 22 199:2,5,24  
 200:10,14,15  
 201:15,16,22,24  
 202:6,8,15,25  
 203:2,21 208:11,25  
 211:19 212:3 213:1  
 215:21 216:16  
 218:7 221:6 224:24  
 226:9,13 237:8  
 239:14  
**transported**  
 184:10 188:8,20  
 191:21,22 202:1  
 227:22  
**Trapp** 93:3 120:19  
**trapped** 132:3  
**travel** 185:16  
**TRB** 148:3  
**TRD** 146:12  
**treated** 123:13  
 133:10,15 203:16  
 228:1 230:8,20  
**treatment** 60:7  
 89:15 123:12  
 177:18 178:2 179:2  
 211:21  
**treatments** 177:22  
 178:13  
**tree** 62:6 105:22  
 107:23

<b>trees</b> 107:19 114:21	132:2 162:9 172:19	169:10 174:1
<b>tremendous</b> 19:15	208:24 210:22	197:10 230:10
66:4 86:23	222:17	<b>typical</b> 23:19 83:24
<b>tremendously</b> 87:3	225:10,11,23	150:15
<b>triage</b> 85:1	226:18 227:1	<b>typically</b> 14:12
<b>trials</b> 136:3	241:19	47:17 237:6
<b>Tribunal</b> 144:17	<b>TTR</b> 239:4	<b>typing</b> 209:12
<b>Tributyl-10</b>	<b>tuned</b> 158:23	<b>typo</b> 3:22
149:18,19 153:1,15	<b>turbulent</b> 212:22	<b>typos</b> 4:8
158:17	<b>turf</b> 7:1 126:18	
<b>trickier</b> 162:13	<b>turn</b> 15:10 32:20	U
<b>tricky</b> 63:2	34:13 84:14 89:9	<b>U.S</b> 32:2
<b>tried</b> 94:18 125:1	105:12 119:9	<b>ugo</b> 50:14
137:3	136:20 168:7 173:6	<b>ultimate</b> 7:13
<b>trigger</b> 205:8,23	180:10,16 213:14	135:18 222:17
<b>trillion</b> 154:2	223:11 242:15	<b>ultimately</b> 128:18
<b>TRIMFATE</b> 128:11	<b>turned</b> 11:15	173:17 174:4
<b>trophic</b> 48:25 60:25	<b>turning</b> 62:13	<b>unable</b> 90:11
67:1,4 70:23,24	<b>turnover</b> 57:18	<b>uncertainties</b>
71:5,6,7,10	<b>turns</b> 96:10 132:1	4:22 53:7 193:5
80:10 87:22	<b>tweak</b> 76:24 82:8	<b>uncertainty</b> 18:15
131:8 134:8,14	<b>tweaking</b> 76:4	20:3 21:14 47:20
<b>trouble</b> 27:17 64:14	<b>twenty</b> 147:23 167:8	76:25 83:10 121:24
<b>trout</b> 80:9	232:5 244:1	162:12 168:4
<b>true</b> 14:17 18:16	<b>twenty-five</b> 192:22	172:13,14,21 193:4
23:10 93:1	<b>twice</b> 193:14 201:12	223:3
105:13 106:2	<b>twist</b> 62:7	<b>uncertainty...sorry</b>
112:17 123:10	<b>tying</b> 33:25 34:10	121:20
169:25 196:7,21	<b>type</b> 7:15 10:19	<b>unchanged</b> 169:4
213:23	19:18,20 23:12	<b>uncouplers</b> 144:17
<b>truly</b> 115:11 169:11	26:7 27:8 41:16	<b>uncoupling</b>
182:23	42:3,9,10,15	144:10,14
<b>truth</b> 220:9	45:16,19 47:17	<b>under...I</b> 8:10
<b>TRVs</b> 160:3	60:4 71:9 74:18	<b>underestimate</b>
<b>try</b> 32:15 43:16	75:2 81:9 98:5	140:17
44:3 64:9 68:17	99:1 107:7 109:3	<b>undergo</b> 188:23
87:19 121:17	110:18 113:23	201:5
125:21 131:11	122:23 132:10	<b>undergoes</b> 202:12
138:16 139:2,3	135:10 146:1 156:6	<b>undergoing</b> 198:18
141:23 164:23	170:16 173:1,17	201:23 226:10
177:9 207:14 221:9	175:8 178:5 185:14	<b>underlying</b> 90:4
224:4,13,17 225:12	186:24 218:7	202:24
230:8 231:6	228:10,19 229:25	<b>understand</b> 10:4
<b>trying</b> 17:10 23:9	230:3,10 237:14	11:7 12:5 18:5
44:1 54:24 77:15	<b>types</b> 6:1,23	28:14 32:16 37:6
91:4,5 95:7 96:7	81:16 112:1,11	39:2 53:6 104:16
118:23 130:24	128:20 131:17	105:21 117:2 123:7



20:15 55:4 70:9	<b>VOCs</b> 21:2	140:12 141:6
108:16,18 111:2	<b>volatile</b> 185:3	142:18 143:14
116:24 202:18	188:9 201:2,4	145:15,16,19
216:20	<b>volatility</b> 92:1	146:13,15 147:11
<b>vary</b> 37:21 87:3	<b>volatilization</b>	148:24 151:25
112:12 142:13	107:12 200:22	152:2,3,5 154:3
161:11 190:7	201:1 202:12	181:1 183:13,21
195:1,13	204:25	184:5,8 185:3,6
<b>vegetables</b> 114:22	207:20,21,24 229:5	186:15
<b>vegetation</b> 126:5	<b>volatilize</b> 200:22	187:2,6,14,16,20,24
127:6	<b>Vonya</b> 186:12	188:12
<b>velocities</b>	<b>Vonya's</b> 186:1	192:10,14,16,17,19
45:1,3,10	193:22	194:13 196:25
<b>velocity</b> 39:12	<b>vouch</b> 23:22	205:20 211:3
45:7,18	<b>vulnerable</b> 123:11	212:14,17 213:12
<b>verify</b> 51:21 55:20		225:13 226:19
<b>versa</b> 96:4		229:2,4,7,9 230:23
<b>version</b> 29:13	W	237:10 239:18
57:12,21 67:10	<b>wait</b> 198:25 231:2	<b>water...or</b> 93:24
239:3 242:5	<b>waiting</b> 178:9	<b>watermelon</b> 116:1
<b>versus</b> 10:23	<b>want...might</b> 136:13	<b>watershed</b>
15:13 35:8 45:15	<b>warm</b> 85:24	38:12,20,23 39:1
63:22 71:13	<b>warm-blooded</b> 54:4	223:24 224:15
76:14 85:2 86:19	<b>warrants</b> 122:10	225:20 226:8,12
87:2 144:22 162:17	<b>was...had</b> 18:7	<b>watersheds</b> 209:2
174:21,24 175:4,9	<b>was...very</b> 4:14	224:19 225:8,18
<b>vertebrates</b> 89:14	<b>Washington</b> 232:9	<b>wave</b> 44:18
<b>vertical</b> 44:15	<b>wasn't</b> 120:17 138:2	<b>ways</b> 88:8 109:15
214:8	200:4 209:16	146:3 147:5
<b>vetting</b> 54:23	210:18 232:21	199:9 201:17
<b>via</b> 47:12 199:25	<b>wasn't...it</b> 120:17	218:14
<b>viable</b> 183:19	<b>water</b> 6:1,23	<b>we...I</b> 92:23
<b>vice</b> 96:4	7:10,12 9:17 18:22	<b>we...I'm</b> 4:10
<b>Vicky</b> 167:3	20:18,23 21:3	<b>we...somewhere</b> 9:13
<b>view</b> 5:19 49:19	22:22,23 28:24	<b>we...we</b> 14:1 61:6
78:8 95:5 109:2	31:9 33:8,22 34:18	87:14 96:20 116:16
124:15 137:9	37:11,17,25	133:13
238:17	38:7,20,25	<b>we...we've</b> 42:20
<b>violate</b> 66:20	39:12,22,25 40:9	<b>we...when</b> 111:4
<b>violated</b> 66:17	43:23 48:24	<b>weak</b> 44:17
<b>violation</b> 24:4	55:12 56:17	<b>weaknesses</b> 164:22
<b>violations</b> 66:17	58:8,12,15,19	<b>web</b> 49:20 50:4
<b>virtually</b> 209:18	68:25 69:6 71:13	53:20 55:10,12
<b>viruses</b> 116:2	79:1 82:12 85:21	57:1,10 58:1
<b>visual</b> 222:14	88:4 93:21,24	59:6 60:13 61:20
<b>VOC</b> 164:18	94:13 96:4,16	80:11 82:12,14
	97:7,11 106:1	84:25 85:9 87:25
	109:22 116:2 126:5	

90:5 112:3 136:17 231:19 234:16,24 31:21 37:20 43:7  
**webs** 51:11 235:21,24 237:5 50:5 56:8,18  
 59:7,25 241:9,19 242:9 58:4 69:21 73:19  
 89:21,23,24 90:2 **were...were** 81:25 76:20 79:6 81:15  
 119:6 **we're...we're** 10:20 84:16 89:1  
**we'd** 49:4,10 177:23 **wet** 228:25 91:10,25 101:4  
 234:4 **we've** 3:3 4:24 14:3 105:2 106:14  
**week** 90:12 209:22 42:11 60:9,10 65:3 107:23 108:23  
**weeks** 191:15 235:16 72:5 74:2,13 75:16 112:17 122:17  
**weigh** 44:12 48:12 83:14,24 97:24 130:13 136:21  
**weight** 113:9 115:14 115:2 132:11 152:9 168:18  
**weights** 108:16 153:13 154:16 169:20 170:4 179:2  
**welcome** 2:8,21 158:16 197:25 184:7 201:8,9  
 5:1 139:11 215:18 215:19 218:17 212:1,2 213:23  
**we'll** 4:22 8:9 229:13 235:15 215:11,12 219:5  
 50:17 61:23 62:9 241:6 227:8 228:22  
 88:13 89:1,7 **We've...in** 74:2 229:12,21 230:7,18  
 93:9 119:11 138:25 **we've...we've** 56:16 238:10,12 241:3,4  
 139:2,7 151:21 105:5 **whether...if** 79:7  
 180:25 209:6,7 **whale** 111:19 **which...but** 77:22  
 215:16 216:5,8 **whales** 63:22,24 **which...which** 57:16  
 244:3 **what...if** 106:25 62:14  
**well...pretty** 108:4 **what...what** 29:3 **white** 6:16,25 36:17  
**we'll...we'll** 3:5 114:24 48:4 49:9 50:1,3  
 138:21 **what...what's** 51:2,16 52:19  
**well-known** 23:21 119:23 58:11 60:8 63:8  
**we're** 3:8 4:20 11:8 **whatever** 9:11 64:19 73:4 115:1  
 20:1 21:6 22:21 21:1 28:7 76:6 122:21 141:15  
 30:5,9,10 32:12 111:5 123:13 145:22 186:19  
 36:5 44:12 50:7 142:22 145:18 216:13 223:21  
 74:24 76:9 146:15 147:24 225:17 226:24  
 83:12,13 85:3,5 177:7 238:11 227:11,15,18  
 87:7 88:23 89:3 **whatever...and** 81:8 230:15 242:22  
 96:7,8 104:23 **whatnot** 232:19 **whole** 13:14 15:14  
 109:7 110:5 233:17 29:4 30:17 77:23  
 111:1,3,22 **what's...what** 95:23 102:15 111:8  
 128:22 130:21 112:3 145:5 156:13  
 131:21 139:7,21 157:10,13,20  
 142:2 145:5 149:11 **wheat** 232:25 158:2,4 163:20  
 151:3 162:22 **when...when** 21:19 166:2 168:25  
 163:16 164:13 60:18 178:16 179:4  
 165:18 166:6 **where...where** 57:22 199:25 211:6,21  
 171:18 182:3 **whereas** 101:14 212:5 215:2  
 193:9,12 197:24 190:21 220:6 221:2  
 206:9 207:3,4,5,21 **WHEREUPON** 88:19 223:6 225:24  
 208:24 215:23 139:10 215:17  
 225:10 229:14 244:5 **who's** 27:13 46:11  
 208:14  
**whether** 6:13,14 **Wick...Dr** 41:19

<b>wide</b> 110:13	115:10 118:23	110:15 121:2 138:1
182:16 189:18	144:2 149:6,10	178:16 222:6,24
210:9 221:7	160:4 161:25	232:10
<b>widely</b> 86:9 115:5,6	163:15 165:1	<b>wrote</b> 120:7 187:12
119:2	166:12 169:9	
<b>wider</b> 111:17	171:23 176:3 178:5	X
<b>wild</b> 112:25 114:20	181:9 196:13 197:2	<b>XAB</b> 193:23
<b>wildlife</b> 90:21	204:5 213:5	
135:25 136:6,14	218:2,21 241:19,20	Y
230:11	<b>worked</b> 53:2 57:10	<b>year's</b> 194:1
<b>Will...Lick</b> 41:6	129:4 163:13 166:5	<b>yesterday</b> 3:1,7
<b>Willie</b> 24:20 27:3	225:22	7:16 34:4 49:6
67:24 207:8	<b>working</b> 21:6	66:13 72:22
<b>Willie's</b> 36:13	25:21 28:5 58:17	79:13 92:23 98:6
<b>winds</b> 41:12	77:12 82:7 85:20	102:23 125:2,17
<b>windspeed</b> 184:19	91:10 92:20	128:11 139:24
<b>wisely</b> 52:22	94:18,19 114:4	159:9 165:23
<b>with...in</b> 72:5	131:4,10 163:22	180:12 214:19
<b>with...with</b> 14:2	171:8 184:18	221:5
53:13 54:10	189:5,7 191:7	<b>yesterday's</b> 5:11
58:17 75:11	193:10 216:3,5	<b>yet</b> 8:5 44:11 65:13
85:9,23 108:17	240:25 241:6,9	114:14 122:22
110:13	242:9	215:11
<b>with...within</b>	<b>works</b> 5:21 31:25	<b>yet...and</b> 60:13
104:23 114:8	53:5 130:8 148:7	<b>Yona</b> 197:1
<b>without...with</b>	157:17 160:18	<b>York</b> 194:14 195:16
81:20	163:15,17 199:16	<b>you...as</b> 24:22 31:9
<b>woke</b> 8:5	<b>workshop</b> 181:5	<b>you...do</b> 43:15
<b>wolf</b> 118:13	205:16 206:20	<b>you...if</b> 10:22 35:3
<b>wolves</b> 118:17	<b>world</b> 96:6,7	<b>you...I'm</b> 77:12
<b>wonder</b> 31:21 168:18	97:17 193:16 196:9	<b>you...the</b> 92:2
170:4 211:2	<b>worry</b> 13:3 31:7	111:24
227:8 228:21	79:7	<b>you...where</b> 17:12
230:14 239:1	<b>worthwhile</b> 81:14	<b>you...you</b> 23:17
<b>wondered</b> 114:24	192:2 230:7	40:24 45:5 54:23
133:6	<b>would...I</b> 32:14	63:16 64:4 68:24
<b>wonderful</b> 60:14	<b>would...that</b> 119:2	104:24 134:9
198:5	<b>would...we</b> 11:23	211:14
<b>wondering</b> 37:19	<b>wow</b> 174:8	<b>you...you...you</b>
135:22 169:20	<b>wrap</b> 25:3 42:20	52:21
208:10	89:4 139:4 181:2	<b>you'll</b> 35:14,22
<b>work</b> 5:20 6:6	<b>wrapped</b> 85:13	68:18 75:14
13:2 18:8 32:15	<b>written</b> 4:12	100:7 141:15,22
49:5 53:3,18 54:20	34:24 139:24	149:1 167:8 233:4
62:11,12 63:4,20	180:13 219:24	<b>your...for</b> 73:1
70:13 87:10	<b>wrong</b> 3:22 66:18,19	<b>your...of</b> 133:4
106:7 107:24,25	69:18 104:13	<b>your...when</b> 82:5

**your...your** 75:11  
83:2 84:11 136:18  
**you're...if** 87:17  
**you're...the** 72:24  
**you're...when** 12:22  
**you're...you'll...**  
**you'd** 64:14  
**you're...you're**  
85:20  
**you've** 12:14  
32:21,23  
38:18,19,22  
41:15,18,24,25  
43:10 45:19  
99:10 122:18  
124:21 126:12,24  
127:14 129:2 133:6  
165:19 176:5,17  
177:1 202:16 226:5  
231:10

---

Z

---

**zero** 35:14 63:13  
**Zibb** 136:10  
**zone** 29:24 61:14  
95:22  
**zooplankton** 55:13