Facilitated Discussion for New Methods Session

THOM HARDY: Guys, come on up. You can't hide anymore. How many people came up with a number for Bill Miller's multi-decadal population dynamics model? Can I get a number, cost?

SPEAKER: $100 million.

SPEAKER: $6.2 million.

THOM: $6.2 million, going once.

SPEAKER: $13.

THOM: Going how much?

BILL MILLER: Model development alone with that initial population estimate, was $670,000.

THOM: $670,000 for the initial model development.

BILL MILLER: Well, and the recent update that doesn't include the $1.2 million per year for the monitoring data that was collected for 20 years.

THOM: Right, $1.2 million a year monitoring for 20 years, basically almost a million dollars for model development [about $25 million total]. I would guess that 90 percent, but Hal Beacher corrected me that 99.99 percent of the people in this room will never have the type of data, time and money to do a Bill Miller type of project. But I think it's brilliant. All right, I'd like to take comments or preferably questions about modeling the new tools. Are we really doing things better? What is the direction?

Very stimulating talks here, so if anybody has a question. No? Okay, we will adjourn for beer. Mr. [unintelligible – Bob Vadas?]?

BOB VADAS: All right. Well, Bob Vadas WDFW. For somebody like myself who's classically statistically trained who's used to thinking, for example, in multiple regression models and what variables are important, how does that output differ from what you get with the uncertainties in Bayesian modeling? Is it complementary information, is it added to the robustness? What does it all mean?

SPEAKER 1: What does it all mean? We end up with posterior distributions right? So, instead of moments or something like that, which you might get from a frequency analysis, there's many things you can do frequency-wise that you can do Bayesian-wise and vice versa. You can **[unintelligible]** a mixed model using a frequency approach or a Bayesian approach, except one ends up with a nice posterior distribution that you then can plug into and iterate through a next period, or a next place in space.

SPEAKER 3: Let me rephrase that. We have a trout model on the Olympic Peninsula where the important variables are hydrology, temperature, stock recruitment, last year's trout population size, and fit **[unintelligible]** carcasses, which is an index of marine drive nutrients. That’s based on multiple regressions. If we were to plug that into something like Bayesian statistics, what will we see? Will we see something similar or something totally different?

SPEAKER 1: Well, first I would say if you can fit it with a regular **[unintelligible]** regression or anything else like that, why would you use Bayesian stuff? However, I would also ask, so your independent variables are measured without error. And if it's not, really, then seriously, you need to -- if you can incorporate that in a Bayesian framework naturally, right? As it is with a frequency method you need to go back to sort of **[unintelligible]** the sort of air measurements models that he came up with a Bayesian framework. It's completely natural.

And in fact, you could actually embed a population model within any kind of framework. It's just this idea of integrated data modeling. Mark Carey talks about it a lot. In a greater population modeling, you can actually get data from different sources and you can plug them into a single modeling framework. And you can do things that you never thought you could. So, for example let's think about Borax[?] Lake chubs, all right? You can mark them, you can recapture them but there's no way they're going to hold a mark, and you can't put permanent marks on them. So how do I build a population model based on that? Well, I can do it. I have mercury capture. I can do it by embedding a population model within a mercury capture model for multiple years. You can't do that in anything else that I know of. The same thing goes -- Mark Carey's book has a bunch of stuff on why you'd want to do it, and I don't want to bore everybody with things here. But there are reasons why.

THOM: Okay, Mr. Annear

TOM: Tom Annear I'm with the Wyoming Game and Fish Department. This is for Jim and/or Bill. The message that you guys just provided were really descriptive. For a guy like me or other people here, how would you use your tool as a prescriptive tool to set a flow or flow regime? Have you done that, Jim and Bill? Can you get back at that through your population model based on if you just want X number of fish aside from that? That make sense?

JIM PETERSON: Yeah, well I did use it when I was at the Georgia Co-op Unit, and we did estimate what were the changes likely to be in distribution and distribution of multiple species, well species richness for fishes as well mussel persistence. You could ask Patty what Georgia DNR is doing with that right now. I think they're embroiled in a lawsuit and I think it's really going nowhere. So yes, we did estimate what the effects were, do a different flow policies that they asked us to look at. We came up with answers, and I don't know where it went.

THOM: I'm quite certain that he was uncertain of that answer.

BILL MILLER: Well, and for the population model that we put together, we have currently the 22 years of existing flow regime, which includes our modified flow regime for replicating a spring peak. We expect to use it to evaluate proposed changes to flow regimes as we evaluate whether we update our recommendations or not so we can project those forward. There's a similar model for hydrology. It's a daily model for hydrology that's in the San Juan Basin, where they can plug in water use, water removal, different flow regimes, and we can run it through our model to analyze that. It's not really set up to be prescriptive for what flow do we need, but we can toy with those flows and run different scenarios to see the impact on the species.

THOM: I'd like to interject. I thought it was interesting because in the San Marcos with the Edwards Aquifer Habitat Conservation plan, very early on, we started developing some Bayesian belief networks and influence diagrams as a way of evaluating minimum flow rates in the San Marcos and Comal River.

But the stakeholders went running into the night and thought Robin's talk today was amazing because we were unable to get them to embrace the concept that we were in fact embracing uncertainty, and they just couldn't go there and they dropped the entire thing and went an entirely different direction. Because I think we weren't effective enough on educating them patiently to get there. But we were actually starting down a path using those techniques to estimate flow regimes. Yeah, it was sad. Other questions. Yes ma'am, yeah.

ANGELA ARTHINGTON: This one's for Tom (Payne). Did you really expect me to be mad at you?

TOM PAYNE: I'm sorry, I didn't hear you.

ANGELA ARTHINGTON: My question is this, SEFA looks like a very sophisticated development beyond PHABSIM. So, is there an intention to build it up the way

IFIM was originally intended to be built, more towards a flow regime perspective?

TOM: Absolutely, to try to merge hydrologic variability using some physical and biological models as the initial stating point and then working towards incorporating the hydrologic variability with the justification of the modeling. So no, I didn't expect you to be mad at me. I was just teasing a little bit.

THOM: You sure were. He's misunderstood a lot. I already knew that he does this, so I was fine with it. So anyway, thanks for the answer, thank you.

RON PTOLEMY: Hi, I'm Ron Ptolemy from the BC Ministry of Environment, Victoria BC. Some people should be engaged on the panel, Dorian. In your description of your **[unintelligible]** case, Dorian, you described a range of flows and cubic meters per second. Can you provide a quick equivalency 2 percent MAD and also what was the ideal optimal flow for steelhead fry in percent MAD?

THOM: I'm really glad you asked him that. I was curious myself.

DORIAN: I don't think we ever came up with a specific optimal flow using that method, but percent MAD I think mean annual discharge was 2.5 cubic meters per second on that stream. So it would have ranged depending on what you decided your in-stream flow or protective flow would be. It would range from 10 percent to upward to 30 percent depending on where would you set that optimal block?

RON PTOLEMY: Those other people beside yourself have looked at the performance of certain life stages for steelhead specifically, and generally speaking, most of the small hydro projects where we have steelhead present on them or where we've gone through fairly strenuous PHABSIM-related type of studies and simulations, generally, I talk about flows that are fine for steelhead at flows in the magnitude of 10 percent of the longterm annual discharge. So in your case, that would be 250 liters per second.

DORIAN: I could look into it for you, but I think there was a 90 percent chance of 5 percent habitat loss at 10 percent MAD and a 50 percent chance at 10 percent habitat loss at 10 percent MAD. But I could look into it for you.

THOM: Dr. Stalnaker, oh I heard that moan.

CLAIR STALNAKER: I'm speaking a little bit better today.

THOM: You sound better, Clair.

CLAIR STALNAKER: I don't want to disagree with Dorian or Tom Payne, but I want to challenge them by suggesting a shift in paradigm in the way we look at hydraulic habitat, as you both talked about. This shift from model input to model output will give you new challenges for developing analyses the future. You could focus efforts and analyses on model output of usable and unusable habitat area and statistical for comparison with independently derived fish observations. Instream flow advocates need to get over the concept that the habitat criteria function (HSC), the shape of that curve, is the Holy Grail of habitat modeling. First, start with the best information available when constructing habitat criteria (HSC concepts), use best judgment to get a set of criteria that reflects what the biologists think the species habitat needs are. Thom put in your habitat modeling software guidance for input of best available HSC (best judgements using Delphi techniques, curve fitting, simple binary criteria, what is available). Let the user decide. Second, proceed with stream sample designs, stratify into representative reaches, etc. conduct field habitat measurements. Third, using best available habitat criteria simulate usable and unusable habitat area within sampled reaches (stratified or complete census). Fourth, conduct independent observations of fish presence/absence within stream sample reaches. Fifth, run habitat models for the discharge present during fish observations and visually determine how well the fish distribution matches computed habitat usability at the flow sampled. This need not take hundreds of observations but should focus on the life stages determined to be critical to population success. Focus on the output of the habitat model as it may or may not agree with fish observations, within sample reaches. Do any observations appear in areas that model output suggests as unusable? Tweak criteria to place all observations within simulated usable habitat areas. This may be an iterative process, and of course for species not well known more observations for habitat development may be necessary.

I feel that the focus of statistical analyses should now shift toward how well model simulated habitat area fits actual distribution of fish, first forecasting fish distributions and determining model output goodness of fit . When the analyst gets to that point, it is an easy step to habitat time series and population models focusing on species life history and periodicity. The first year of species life history is most often the critical part of modeling for obligate stream fish species. Visual examination of habitat time series can reveal that part of the stream wetted surface area that becomes completely unusable under different flow regimes. The change in orders of magnitude of unusable habitat area for early life stages and shifts in distribution of larger fishes by changing the level of the base for peaking-hydro flow regime is most dramatic. Focus statistical evaluations on how well output of habitat models fit observed distribution within stratified stream samples that also used as habitat verification reaches. Think of habitat criteria (HSC) simply as factors that can be adjusted to calibrate the biological sub-model just as velocity adjustment factors are used to calibrate the hydraulic sub-model for developing habitat time series models. Habitat time series are valuable for determining how alternative flow regimes may impact life stages of fish species and are more accepted when based on field verified habitat models. The paradigm shift is movement away from continued placement of considerable effort toward producing ‘perfect site specific HSC” as model input, and then assuming that the habitat model output will automatically be good.

Rather, start with best available even imperfect habitat criteria as model input; establish stream sample reaches; complete habitat modeling for reaches; observe fish distributions; compare fish distributions to simulated usable and unusable habitat area under the wetted surface; calibrate as necessary to obtain a good fit (all fish observations within usable area and none in unusable areas). This approach should move the science of instream flow away from arguments about the best shape of the HSC curve and toward habitat verification. We need to know how the fish respond to our models of their world. We worked with the Norwegians many years ago and they felt that weighted usable area simulations with areas having values of 0.1, 0.2, 0.3, . . 0.9, 1.0 etc. was too complicated. Why not use simple binary criteria and view simulated habitat as either useable or completely unusable. The Norwegians further subdivided the usable habitat area into suitable and indifferent. We now typically refer habitat simulation areas under wetted stream area as either optimum, marginal or unusable. Model calibration in this context examines habitat model output from the sampled reach followed by comparison to observed fish distributions. Habitat criteria are tweaked as necessary until model output agrees with observed fish distributions. During habitat time series analyses what the instream flow analyst looks for are the amount and timing of flow regimes that shift that part of the wetted stream area from usable to completely unusable for given life stages when they are present (periodicity). Looking at different flow regimes and how they produce varying habitat regimes helps the instream flow analyst to differentiate among management scenarios and negotiate for favorable habitat conditions for species (or guilds) of interest.

The degree of usability, whether it's .75 or .834, really has no biological meaning and certainly doesn't mean anything to the public and decision-makers. When habitat analyses produce visual diagrams of habitat usability from proposed flow regimes, the viewer can recognize how the usable habitat shifts by season and years under proposed regimes. The instream flow advocate can readily explain how the change in flow regime determines significant change in usable habitat and its influence on the fish distribution and life history success. Visual presentation of habitat response to altered flow regimes better informs the public and decision makers so they can follow arguments that favor reducing impacts. In sum, I firmly believe that habitat model verification resulting from tweaking best available habitat criteria is preferable to exclusively focusing on site specific criteria development while ignoring habitat time series with illustration of impacts resulting from alternative flow regimes on life stages of aquatic organisms. Instream flow science needs a paradigm shift in the way practitioners think about hydraulic habitat. Enough said.

THOM: There you go. Thank you, Clair. When young master Dorian was leaving me, I told him envelope curve, envelope curve. I did a similar thing plotting up every curve I could find, and I took my glasses off and I said well, all this is telling me across all these different systems and techniques, this is the basic area under which I find usable habitat. And that just -- at the level of biological resolution resonates with me then I'm not so finally dialing down what I perceive to be my understanding of the organisms' response.

So I think that's the difference is I would have drawn an envelope curve around those and put those in rather than worrying about individual shapes of the curve, like Clair said. But I'm getting to the point where I believe suitability curves are model calibration parameters. I think they can be dialed in until predicted versus observed habitat matches with your distributions. Now you have a model you can begin to believe in. That's my personal opinion. I like this guy. At least somebody in the room agreed. Another question for this esteemed panel?

NATASHA NEWMAN: I feel like I should apologize. People probably want to leave.

THOM: Your name please.

NATASHA NEWMAN: Yeah, Natasha Newman. I'm a private consultant out of Kelowna, British Columbia, so Okanagan. Most of my work is with First Nations communities as well as local government planning groups. I'm not sure how to phrase this as a good question, so maybe just some comments. A lot of what we talk about is optimal curves or optimal habitat availability flows for optimal conditions. So that to me is an average water year. How can I communicate to managers or what tools are there to talk about a dry year? What are some minimums? Sorry to use the term "minimum." But there will be some dry years when we can just say this is what we need just for the species to survive in the stream, so optimal versus minimum. Any thoughts or capacities in the [unintelligible] model at all?

THOM HARDY: I designate Tom as our spokesman on this.

TOM PAYNE: Okay, thank you. Optimal – this is one use of the models that I've seen very, very frequently, and the link to the hydrology is really critical. I didn't see Dorian address the availability of water over time because optimal conditions can be instantaneous, and fish populations cannot respond to instantaneous conditions. That takes fish time to adapt and either grow or recruit into available habitat, which might be there only for short periods of time. So you have to craft and allow for that. If you craft a flow regime that's based on, say, your average conditions, it may or may not be optimal. You might have different flow regimes or different prescriptions for different water year types. And you can set some lower thresholds for the drier years. Let's say you cannot take out nearly as much as you might in the higher years. So the concept of optimal is on very shaky ground, and you have to be quite careful of that. If you look at these habitat index curves, they are independent of hydrology. They are independent of the availability of water. And so, if you say you want the peak of the curve or describe the optimal, that may or may not exist in the real world. So that's why you have the link with the availability of water before you can really even begin to say if there is a habitat loss because it could be unoccupied habitat. Habitat is a condition over time, and if you don't have that, then you're missing a very large part of the picture.

CLAIR: I'm going to come to young Darian's defense here a little bit. I think the subtlety difference here, Tom, is that he measured empirically and kept his analysis within a measured band and was referring to optimal within that range versus simulating outside measured data to which it's a theoretical curve without hydrology. His was internally self-consistent because of the range of flow. So I think there's a subtle difference there. I think the other thing is that if you read the IFC literature, it's clear that they talk about an ecological flow regime and they would expect differences between wet, average, and dry years, and therefore the prescription of an in-stream flow regime needs to accommodate that variability. So you tell the managers, "I expect to have low flow conditions. And when it is low flow, these are the kind of flows I expect, and that's okay. But when I have more water in the system, I need more water for the populations," like Tom said, "to be able to integrate that over time and respond to those new conditions. And that's consistent with the IFC mantra of magnitude, timing, frequency, duration, rates of change.

THOM: We have a frequent question flyer here Mr. Vadas. We'll get back to you, Bob. Tim?

JIM PETERSON: Yeah, Tim Hardin, Oregon Department of Fish and Wildlife. This is maybe for Mr. Payne but maybe for everybody up there too. Oregon is unusual, and the fact that we sometimes run into disputes with water users, I don't know if that probably happens in other places. And using the various models within IFIM, now within CIF[?] and other places, we can measure and recommend a spawning flow, maybe a rearing habitat flow, probably a channel maintenance flow, maybe an out migration flow. But then when we start talking about we want a variable flow regime, then the water users are all over us and saying, "Well you just want variability for variability's sake and you can't really relate that back to fish." And they say worse things too, but I'll leave it at that and let you guys take it from there.

THOM: Is there a question there?

JIM PETERSON: Well, I think Tom [Payne] stated it very well with the last response that this flow regime that you would derive incorporates that type of variability of wet, dry, average in our annual variation. All those things should be incorporated because that's what the fish evolved with. And if you're going to promote those species and their continued existence, you incorporate that into the flow regime. Now, that may be difficult to get into the regulatory framework, but I think that's the direction you should go.

THOM: Tim I think one of the strongest arguments I've heard is if you want to look at the implications of a single type flow regime, look at the loss of vigor and hatch repopulations versus natural populations. If you talk to any angler that pursues salmon and other fish, they will tell you there is a quantitative difference in the behavior of native stock to hatchery stock. And if you think about hatchery, they're in a monochromic environment, and they lose vigor. And to me that's one from a conservation biology, one of our strongest empirical arguments of why we need variable flow regimes.

THOM: Bob?

BOB VADAS: Just a comment -- what was in [unintelligible] Fish and Wildlife, nobody knew that. Okay. So anyway, I was going to say now what we often find with Washington and we're comparing hydrology to PHABSIM is oftentimes the optimal curves are usually higher than the ambient flows and particularly for smaller streams and larger streams or maybe part of the year where the fish [unintelligible] spawning and the rearing curves are suggesting that there's some "surplus" without consideration of you flows, channel maintenance, all that repairing or whatever. But ultimately, the fact that we tend to find optimal flows much higher than ambient flows, to me, strongly suggest that flow is limiting and that I would use as the work in hypothesis that the greater that discrepancy the greater the evidence is for flow limitation. And if anybody has actually tested that, that would be interesting hearing about.

THOM: Again, with the optimum conditions, you have the delay and the response of the populations. And since there is not necessarily a direct correlation with that, you can have limitations in your populations that you can't really say that the peak of the curve is an optimum, unless you have an infinite supply of water and you address all the other considerations that you want to incorporate into a regime. And so, if there is less water than there is an optimum, then that means that the populations are not at optimum. And so you have to be interpreting again, that's why you want to put in the hydrology because the shape of the curve becomes much less significant, as it should, if you do incorporate the hydrology, because you're looking for persistence of habitat over time. And it can be very misleading when you talk about what might be optimum or not.

THOM: But we also might look at a paper by [Jowett?], who looked at reduction of a stream flow for brown trout where they thought there was too much water in the system and did measure a response – Tom (Payne), do you remember what that paper was? I can't remember. I think they took out 300 [unintelligible] or something from this large stream in New Zealand, and they actually got a positive response in the brown trout population. So, [Jaled?, Jowett?] New Zealand. I can't remember the date, yeah.

THOM: So I have a question for all y'all. So optimum, what do you mean by that? What are your objectives? So Tim, what are your objectives? Do you want the most fish you can get in a given year, or do you want the most fish over a longer time period? Are you willing to take a hit for a few years? You guys, all this stuff makes a difference. I'm a modeler. I have to know this. When you're talking about optimum, I got to know this stuff, right? So how do you want it? And I don't -- most times when I ask these questions, I don't get answers to them, and it's for all you guys to answer.

THOM: You got Annear out of his seat. This will be good.

TOM ANNEAR Thom, you did an excellent job responding into finding optimum before, but, frankly I'm sitting here thinking "optimum" is just as dangerous a word as "minimum," because so often, as a biologist, you hear the word "optimum," you're thinking flow regime, you're thinking over time the kind of things we talk about. Just like when you say "minimum," people are saying well, it would get down there, but then it will come back up. It's always a single flow when we think optimum or minimum. And so, I do think it's very important to use all the words when you say optimum and say optimum for what. And frankly, I think people don't know what optimum is. You have to do like Allan Lock would do and say, "What would the fish think?" I'm not a fish, so I don't think it's fair for me to say what's optimum. I can talk of other words – maximum, more, less – that sort of thing, but I just think optimum is one of those really dangerous words that plants a seed in somebody's head that there's nothing better so we should use some other descriptor or other words in place of optimum. I see Ian is going to jump into this. We could round and round on this one, I think.

IAN CHISHOLM: Ian [Chisholm], Minnesota. The other thing that I think we're getting often to here is that the river is not about just fish. We're talking about ecology here, and it's bigger than just the pieces. So somehow, even if we're talking about extremely elegant stuff that Bill's been working on, very complex, as much as they could think of important to for 22 years or whatever, it's still bigger than that. And so, I think somehow we have to temper all this "what do you ask for" with the fact that this is a natural system out there. It's much bigger than a manager, I think, can do justice to.

THOM: You have objectives, right? You don't really care about green sunfish. I don't care about green sunfish.

IAN: I think the objectives I'm talking about is maintaining or protecting that healthy system.

JIM PETERSON: Okay, so what are the measurable attributes of that system? I always walk my way down that list. I think a lot of times when something is really complicated, we tend to gloss over and say we want everything to be awesome. But for me, when I go into these situations—and Robert's not here, I don't think—but I usually like to ask specifically what are your objectives, one of the things -- well, I want a healthy ecosystem. Okay, what does that mean to you guys? And I'm asked by a biologist, say, well "We want to do no harm," what do you mean by harm? And I think we need to be really careful and explicitly state what our objectives are. And doing good things means different things to different people. So we all want to do good things. I think we can all agree to that. But I bet you it'd be different for everyone in this room.

THOM: That's a good point, Jim. Okay, I'm going to close this down. I'd like everybody to give me a round, a hand of applause for this expert panel. And it's with great pleasure to introduce our wrap-up number four hitter here, Christopher Estes, I've know Christopher for a number of years. I have the utmost respect for him and what he's accomplished for preservation of our aquatic resources, nationally and internationally. And I think it's all worthwhile if we pay attention to what Christopher has to say because there will be an exam at the end.