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From: Rawding, Daniel J (DFW)

Sent: Thursday, February 07, 2013 7:39 PM

To: 'William Jaeger'

Cc: 'Leonard, Nancy'; 'pete.hassemer@idfg.idaho.gov'; Tom Rien ([Tom.A.Rien@coho2.dfw.state.or.us](mailto:Tom.A.Rien@coho2.dfw.state.or.us)); Norman, Guy R (DFW); 'randy\_fisher@psmfc.org'

Subject: RE: Question about fish tag options in commercial fisheries

Bill,

Sorry for the delayed response.

CWT are the only means of estimating harvest from the ocean based on political and practical considerations. The political is that ocean harvest is governed by the Pacific Salmon Treaty between the US and Canada and the CWT is the only tool agreed to by the parties to estimate harvest rates. One of the US Commissioners, Larry Rutter, discussed tagging within the treaty with Tagging Forum last year. The practical consideration is a portion of the ocean catch occurs in the commercial troll fishery. These fish are immediately dressed (gutted) and iced. Since juvenile salmon are PIT tagged in the peritoneal cavity (belly), the dressing of adult salmon cause the PIT tag to fall out thus these fish cannot be sampled. Therefore, PIT tag option can only be realistically considered for salmon not harvested in the ocean. This effectively eliminates the use of PIT tags for Chinook and coho salmon, which have significant harvest rates in the ocean

A second concern is that juvenile salmonids should be greater than 65mm to PIT tag (CBFWA 1999, page 18). The minimum size recommendation have been implemented because there can be substantial mortality for small juveniles during the tagging process. Therefore, this effectively eliminates juveniles that emigrate shortly after emergence, which include fall Chinook and chum salmon.

The third issue is that the Columbia River PIT tag infrastructure is concentrated above Bonneville Dam (BON). The infrastructure occurs at BON and other mainstem dams, and in tributaries to the Snake and Columbia rivers. The statistical model that I have developed for estimate harvest rates rely on sampling of fisheries as the numerator and the BON detection in the denominator. Without a substantial investment PIT tag infrastructure in the tributaries below BON harvest estimate for these populations is not practical. The reason you need the tributary detection is that when salmon spawn, they often expel the PIT tag because it can remain loose in the peritoneal cavity.

Given the ocean, location, and size constraints this effectively leaves PIT tags as a practical option for steelhead and sockeye salmon populations above BON. There may be some Chinook population that have limited ocean harvest but I would need to research this further.

Finally, you appeared to be settling into a PIT or CWT proposal to estimate harvest. Harvest estimates for PIT tags that I developed are based on the binomial distribution. Both Bayesian and maximum likelihood methods can be used to combine information from different sources including PIT, genetic, and CWT. The reason, I bring this to you attention is that staff that sample Columbia River fisheries below the confluence of the Snake scan all fish for PIT and CWT tags, and collect genetic samples as needed. Therefore, there is a small increase funding to sample fisheries for both CWT and PIT tags. Combining likelihoods or Bayesian posterior distribution from multiple sources does improve the precision of estimates. Therefore, the potential use of multiple sources of information should be considered rather than a CWT or PIT tag approach. Sometimes these are termed integrated models.

There are no direct answers for the questions you ask. So let me walk through some of the PIT tag math so you can better understand how we may arrive at an answer. First, we try to sample the fishery at a 20% sample rate (SR), what this means want to sample (Samples) ~20% of the total catch (Catch) as in Equation 1. For this simple example we will sample at a 20% rate over the entire fishery. Next we multiply the number of PIT tags detected (PIT\_det) by the sample rate to estimate the expanded number of PIT tags (Exp\_PIT) caught in the fishery (equation 2). Finally, we estimate the harvest rate by noting the harvest rate (HR) is a function of the expanded PIT tags caught in the fishery and those detected at Bonneville Dam (BON\_det) as in equation 3.

Samples ~Binomial(Catch, SR) equation 1

Exp\_PIT <- SR \* PIT\_det equation 2

Exp\_PIT ~Binomial(BON\_det,HR) equation 3

These approximations should be good enough to estimate precision for your model. However, these will underestimate the precision because these sample rates vary by week and we sum these over each week during the fishery period. Second, the BON detection is closer to 98-99% and it has some uncertainty with it. Also you probably need the SAR to BON and approximate harvest rates for the precision calculation.

The finally issue is the reporting group for harvest. Fish populations are hierarchically organized within the Columbia Basin. I will use steelhead as an example. All summer steelhead populations above BON are an aggregate but are divided into 4 distinct population segments (DPS) including the Lower Columbia River (LCR), Middle Columbia River (MCR), Upper Columbia River (UCR), and Snake River (SR). Now the SR has two groups A-runs (SR-A), which generally returns earlier and smaller, and B-runs which generally returns later and larger (SR-B). So now we have 5 larger management groups (LCR, MCR, UCR, SR-A, SR-B). In addition, some further divide these 5 groups into hatchery and wild making 10 management groups. The reason for this division is that except for the treaty fishery all other fisheries require the release of all wild steelhead thus differential harvest rates. Finally, there are major population groups within each group and populations within each major population group. I have used the 5 groups split between hatchery and wild in my reporting of harvest rates.

Now for your modeling, a decision may be to tag a single populations as an indicator for the 10 management groups or representative tagging for all groups. My harvest estimates are currently based on opportunistic tagging, where I am using tags for other purposes such as habitat evaluation, transport in river survival, comparative survival study, hatchery evaluation, and many other purposes.

As for the level of precision, I have not any specific guidance but will continue looking. I should be able to provide a PIT tag harvest report for 2010 next week and 2011 the following week.

CBFWA. 1999. PIT tag marking procedures manual. <http://www.ptagis.org>

Remembered one more thing. We notice that harvest is age or size selective, which mean that fish of different sizes or ages are harvested at different rates. So for an unbiased steelhead harvest estimate, this would require separate estimates for age 1 and age two and older fish.