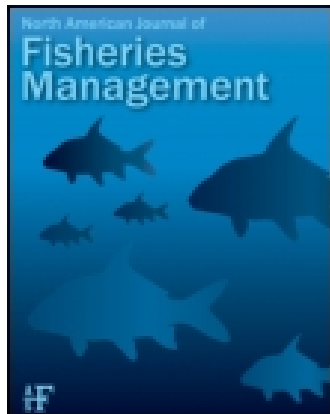


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### Comment: Population Structure and Run Timing of Sockeye Salmon in the Skeena River, British Columbia

Michael H. H. Price<sup>a</sup>, Andrew G. J. Rosenberger<sup>b</sup>, Greg G. Taylor<sup>c</sup> & Jack A. Stanford<sup>d</sup>

<sup>a</sup> Skeena Wild Conservation Trust, 4505 Greig Avenue, Terrace, British Columbia V8G 1M6, Canada

<sup>b</sup> Raincoast Conservation Foundation, Post Office Box 2429, Sidney, British Columbia V8L 3Y3, Canada

<sup>c</sup> Watershed Watch Salmon Society, 1037 Madore Avenue, Coquitlam, British Columbia V3K 3B7, Canada

<sup>d</sup> Flathead Lake Biological Station, University of Montana, 32125 Bio Station Lane, Polson, Montana 59860, USA

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COMMENT

## Comment: Population Structure and Run Timing of Sockeye Salmon in the Skeena River, British Columbia

In their article, Beacham et al. (2014) acknowledge that

[t]he underlying priority in management of the [Skeena River Sockeye Salmon *Oncorhynchus nerka*] fishery is one of conservation first of stocks and species of conservation concern, and secondarily where and when possible, allowing for harvest of more abundant stocks of Sockeye Salmon.

The authors then describe genetic stock identification at a salmon test fishery as a novel and important technique with which to estimate population abundance for fisheries management and protect populations of concern. While we agree that the conservation of salmon is the highest priority for fisheries management, we believe that Beacham et al. fail to consider the appropriate population-level structure required for conservation in Canada, do not emphasize the complexity of the Sockeye Salmon populations in the Skeena River catchment, and overstate the approach's utility in contemporary salmon management. Ultimately, the proposed approach will not achieve the necessary conservation goals because of the substantial overlap in the return of wild and artificially enhanced Sockeye Salmon.

A primary objective of Canada's Policy for Conservation of Wild Pacific Salmon (WSP) is to sustain the genetic and geographic diversity of wild salmon and preserve their habitats through the protection of conservation units (CUs; DFO 2005, 2009). Despite the importance of this fundamental structure for management decision making, monitoring, and conservation, there was no mention of CUs in Beacham et al. (2014). Instead, the authors examined 27 populations that in their genetic analysis segregated into 12 "stock reporting groups." In the Skeena River catchment, there are 31 lake-type and 2 river-type Sockeye Salmon CUs (Holtby and Ciruna 2007; our Figure 1); only 9 of the 33 CUs can be identified genetically as a CU with >95% confidence at the Tye test fishery (Beacham et al. 2014; our Table 1). Importantly, more than one-half of the Skeena River Sockeye Salmon CUs for which there is enough information to determine abundance status are "of concern," including some that are severely depressed (Korman and English 2013; our Table 1). In not focusing on CUs, Beacham et al. do not fully account for their inherent genetic, life history, and geographic uniqueness,

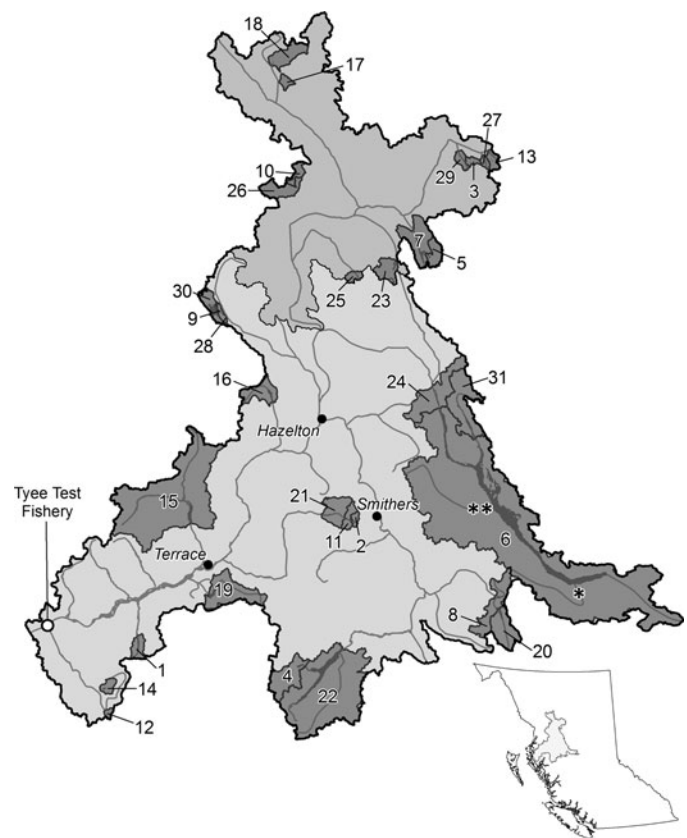


FIGURE 1. Skeena River catchment lake-type (dark gray [numbers correspond to those in Table 1]) and river-type (medium gray = Skeena River-High Interior; light gray = Skeena River) Sockeye Salmon conservation units. Asterisks indicate the locations of the Babine artificial spawning channels.

which is the focus of the conservation objectives under the WSP.

Beacham et al. (2014) briefly describe the dynamics of the Skeena River commercial fishery, whereby artificial spawning channels in Babine Lake have annually increased Sockeye Salmon production for fisheries yet resulted in less productive wild populations that have been subject to overexploitation. They state that "[t]he identification of timing of the return of

TABLE 1. The 33 Sockeye Salmon conservation units (CUs) in the Skeena River catchment. Location numbers correspond to those in Figure 1; “Genetic baseline” refers to whether or not a particular CU has a genetic baseline; “Tyee identified” refers to whether or not a CU can be identified in the Tyee test fishery with 95% confidence; “Proportion” is the estimated stock composition identified at the Tyee test fishery; and “Status” is the abundance status estimated by Korman and English (2013). Conservation units without an assigned status are data deficient.

Conservation unit	Location	Type	Genetic baseline	Tyee identified	Proportion	Status
Alastair	1	Lake	Yes	Yes	2.6 (0.6)	Green
Aldrich	2	Lake	No	No		
Asitika	3	Lake	No	No		
Atna	4	Lake	No	No		
Azuklotz	5	Lake	No	No		Green
Babine	6	Lake	Yes	No		Amber
Bear	7	Lake	Yes	Yes	0.8 (0.4)	Red
Bulkley	8	Lake	No	No		
Club	9	Lake	No	No		
Damshilgwit	10	Lake	Yes	No		Green
Dennis	11	Lake	No	No		
Ecstall, lower	12	Lake	No	No		
Johanson	13	Lake	No	No		
Johnston	14	Lake	No	No		
Kitsumkalum	15	Lake	Yes	Yes	2.0 (0.5)	Green
Kitwanga	16	Lake	Yes	Yes	0.3 (0.2)	Red
Kluatantan	17	Lake	No	No		
Kluayaz	18	Lake	No	No		
Lakelse	19	Lake	Yes	Yes	1.4 (0.4)	Amber
Maxan	20	Lake	No	No		
McDonell	21	Lake	Yes	Yes	0.9 (0.3)	Green
Morice	22	Lake	Yes	Yes	1.2 (0.4)	Red
Motase	23	Lake	Yes	Yes	0.1 (0.1)	Amber
Nilkitkwa	24	Lake	Yes	No		Red
Sicintine	25	Lake	No	No		
Slamgeesh	26	Lake	Yes	No	0.9 (0.4)	
Spawning	27	Lake	No	No		
Stephens	28	Lake	Yes	No		Green
Sustut	29	Lake	Yes	Yes	0.5 (0.2)	
Swan	30	Lake	Yes	No		Red
Tahlo–Morrison	31	Lake	Yes	No		Amber
Skeena River		River	No	No		
Skeena River–High Interior		River	No	No		

specific populations from information gained through fisheries is thus a key component of reducing exploitation on populations of conservation concern.” We agree wholeheartedly. However, the coarse resolution of Beacham et al.’s (2014) results, whereby all wild Babine Sockeye Salmon CUs (each known to have a unique run time; Smith and Jordan 1973; Figure 2A) are grouped genetically with artificially enhanced fish as a “middle run time,” would not prevent the exploitation of these CUs of concern in mixed-stock fisheries and fails to meet the intent of the WSP. More broadly, the authors’ proposed approach of using temporal differences in run timing to target or protect specific CUs

will not be effective because there are large overlaps in run timing (Figure 2B), run timing is highly variable between years, and the annual variation is not consistent among CUs (Cox-Rogers 2012). Importantly, run times are calculated through the Tyee test fishery after the fish have passed through the marine mixed-stock fishery; hence, there is no measure of CU composition prior to the impact of the fishery. While a few CUs with extremely early run timing might be managed separately, the majority cannot be (Walters et al. 2008).

Beacham et al. (2014) state that “[t]he application of genetic stock identification technology to a salmon test fishery

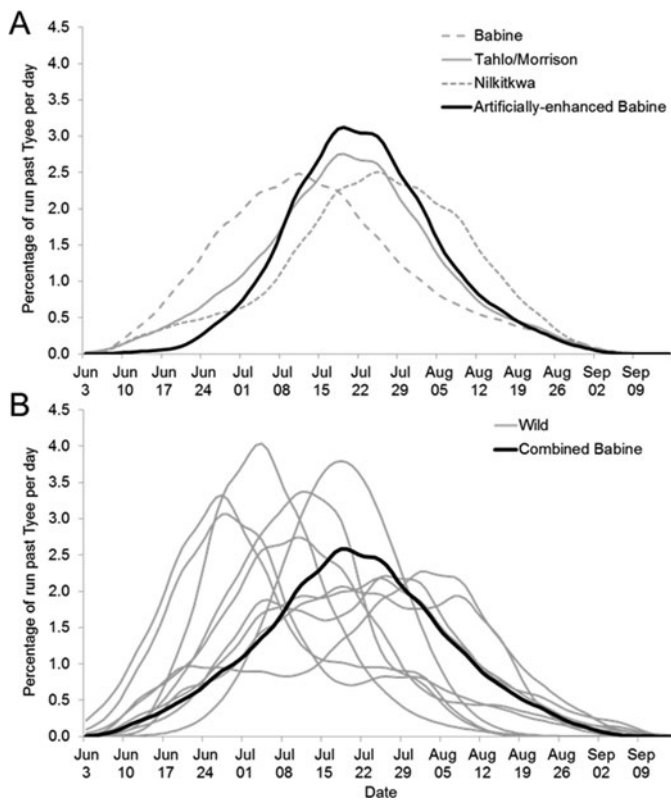


FIGURE 2. Average weekly percentages of Skeena River Sockeye Salmon passing the Tye test fishery. Panel (A) shows the average run times for wild Babine conservation units (Babine, Tahlo–Morrison, and Nilkitkwa) and artificially enhanced Babine Sockeye Salmon. Panel (B) shows the average run times for 11 wild (Lakelse, Alastair, Zymoetz, Morice, Kispiox, Sustut, Slamgeesh, Motase, Bear, Kitsumkalum, and Kitwanga) and the combined wild and artificially enhanced Babine Sockeye Salmon stock reporting groups reported by Beacham et al. (2014). All run time data are for the period 2000–2010 (reported by Cox-Rogers 2012).

can provide a powerful and cost-effective method of estimating relative population abundance and timing for application in fishery management.” While we agree that the genetic approach proposed by Beacham et al. can provide useful information for complex mixed-stock ocean fisheries, we feel the authors overstate the approach’s utility in contemporary salmon management in two ways. First, the proposed approach currently is unable to identify 72% of Skeena River Sockeye Salmon CUs, which is the appropriate population-level structure required for fisheries management in Canada (DFO 2005, 2009; our Table 1). Sixteen of 33 CUs currently do not have baseline genetic information and therefore remain unassigned stocks in the Tye test fishery. The inability to differentiate CUs of concern fails to address the exploitation-related problems that these populations face. Second, the stock composition estimates are imprecise for populations that comprise <5% of the relative abundance in the fishery (Beacham et al. 2014). With the exception of the aggregate Babine Lake group, there is no Skeena River stock reporting group that comprises more than 2.6% of the relative

abundance in the fishery; half of all stock reporting groups comprise less than 1% of the relative fishery abundance.

Beacham et al. (2014) declare that “[d]etermination of spawning escapement is one of the key pieces of information required in the assessment of the status of specific salmon populations.” We agree, and we acknowledge that such escapement estimation is difficult to perform by visual observation. However, we disagree that the Tye test fishery can provide an alternative and reasonable determination of spawning escapement for Sockeye Salmon CUs as required by the WSP (DFO 2005, 2009), especially for small populations of conservation concern. This is because the majority of Skeena River CUs remain anonymous in the Tye test fishery; the genetic identification is performed postseason rather than during the fishery; and of the stock reporting groups that can be identified, all but one (Babine Lake) have such low abundance that the stock composition estimates are imprecise. As Walters et al. (2008) confirm, “[t]he [Tye test] fishery provides at best only a ‘noisy’ estimate of escapement (plus or minus 20% of run size).”

Beacham et al. (2014) imply that the detection of blocked spawning grounds for Kwinageese Sockeye Salmon was due only to a Nass River test fishery, which is erroneous; had the test fishery alone (i.e., without spawning ground surveys) been responsible for escapement estimates, the habitat concern and resulting reduction in spawners may never have been known. Importantly, ground site visits and overflights provide much more detailed information (such as changes to habitat quality and quantity, and disease events on the spawning grounds) than the Tye test fishery. Furthermore, other viable and cost-effective ways to count fish on the spawning grounds (such as camera-equipped drones and fixed-position remote cameras) should be considered.

In summary, the approach proposed by Beacham et al. (2014), whereby stock reporting groups are assigned to one of three broad run times, will not achieve the necessary conservation goals of the Canadian federal government’s WSP because of the substantial overlap in the return of wild and artificially enhanced Sockeye Salmon and the lack of concurrent genetic identification of the CUs of concern. If the goal of fisheries management for Skeena River Sockeye Salmon is to conserve vulnerable CUs while catching abundant artificially enhanced Babine fish, management must move a larger proportion of the fishery in-river and to terminal locations so that populations of concern may reach the spawning grounds. Yet if what we have done in building the Babine spawning channels is to create a situation in which we literally cannot manage the Skeena River Sockeye Salmon fishery according to the WSP, perhaps it is time for Fisheries and Oceans Canada to reduce channel production. Indeed, “if conservation objectives of the Wild Salmon Policy are focusing on concerns about wild Skeena Sockeye, then reduced smolt output from Babine Lake would help those stocks” (Walters et al. 2008). Such a reduction would simplify Sockeye Salmon fisheries management in the Skeena River and help meet Canada’s stated goals of conserving vulnerable conservation units.

MICHAEL H. H. PRICE\*

*Skeena Wild Conservation Trust, 4505 Greig Avenue,  
Terrace, British Columbia V8G 1M6, Canada*

ANDREW G. J. ROSENBERGER

*Raincoast Conservation Foundation, Post Office Box 2429,  
Sidney, British Columbia V8L 3Y3, Canada*

GREG G. TAYLOR

*Watershed Watch Salmon Society, 1037 Madore Avenue,  
Coquitlam, British Columbia V3K 3B7, Canada*

JACK A. STANFORD

*Flathead Lake Biological Station, University of Montana,  
32125 Bio Station Lane, Polson, Montana 59860, USA*

\*Corresponding author: [pricem@skeenawild.org](mailto:pricem@skeenawild.org)

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