**Assessing potential trophic effects of an introduced organism**

**prior to entry to nature**

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# ECOPATH WITH ECOSIM METHODOLOGY

Ecopath with Ecosim (EwE) version 6 was used in this study. The parameterization of an Ecopath model is based on balancing production and consumption (Christensen & Pauly 1992). Based on the principle of conservation of matter within a group, consumption is considered to be the sum of production, respiration and unassimilated food. The following equation describes how the production terms for each group are divided:

 (1)

In this equation, *Bi* and *Bj* are biomasses of prey (*i*) and predator (*j*); *P/Bi* is the production/biomass ratio; *Yi* is the total fishery catch rate of group (*i*); *Q/Bj* is the consumption/biomass ratio; *DCij* is the fraction of prey (*i*) in the average diet of predator (*j*); *Ei* is the net migration rate (emigration – immigration); *BAi* is the biomass accumulation rate for group (*i*); and *EEi* is the ecotrophic efficiency, a catch-all term that describes the proportion of mortality explicitly accounted for in the model such as predation and fishing mortality. (1-EEi) represents other mortality generally only including minor factors such as mortality due to old age, diseases, etc. EE should be between 0 and 1 to allow the existence of other mortality.

Ecosim (Walters *et al.* 1997) provides a dynamic simulation capability at the ecosystem level, with key initial parameters inherited from the base Ecopath model. Biomass dynamics are described as follows:

 (2)

where *dBi/dt* represents the biomass growth rate of group (*i*) during the interval *dt*; g*i* represents the net growth efficiency (production/consumption ratio); *Ii* is the immigration rate; *Mi* and *Fi*are natural and fishing mortality rates of group (*i*), respectively; *ei* is the emigration rate; and *f(Bi*, *Bj)* is a function used to predict consumption rates of predator (*j*) on prey (*i*) according to the assumptions of foraging arena theory (Walters & Juanes 1993; Walters & Korman 1999; Walters & Martell 2004; Ahrens *et al.* 2012). This predator-prey functional response is dependent on Ecosim’s vulnerability parameter, which defines the maximum allowable increase in predation mortality under conditions of high predator abundance (i.e., this parameter defines the current position on the feeding functional response in relation to the predation mortality asymptote) (Christensen & Walters 2004; Ahrens *et al.* 2012). Depending on the value used for this parameter, it defines a predator controlled (‘top down’) or donor driven (‘bottom up’) feeding relationship.

# ECOPATH WITH ECOSIM MODEL PARAMETERIZATION

We modified the recent EwE (version 6) SoG model for the year 2005 (Li *et al.* 2010). There are two salmon groups in the model: transient salmon (including sockeye, chum (*Oncorhynchus keta*), and pink (*O. gorbuscha*)) and resident salmon (including coho salmon and chinook salmon (*Oncorhynchus tshawytscha*)). As transient salmon only pass the SoG and migrate to the Pacific Ocean, we pay more attention to the resident salmon group. We added one GH transgenic coho salmon (GH coho) group to this SoG Ecopath model with 39 functional groups (Li *et al.* 2010). We set its initial biomass the same as the wild resident salmon. GH coho have an inherently larger appetite and a higher feed intake, consuming about 3 times as much food as non-transgenic coho of the same size when excess food is available (Devlin *et al.* 1999). However, in natural streams, GH coho could not realize their full growth potential (Sundström *et al.* 2007) due to presence of predators and complex habitat. We thus set Q/B to 14.6, twice that of resident salmon. GH coho have an enhanced ability to effectively utilize digestive energy and have about a 10-20% higher food conversion efficiency (Devlin *et al.* 2004; Raven *et al.* 2006; Higgs *et al.* 2009). Thus we assume a P/Q 20% higher than the resident salmon and estimated P/B of 5.26 for GH coho. The EE of GH coho is as low as 0.15, suggesting fishing and predation only contribute a small proportion to the total mortality in the model. This allows a large amount of GH coho to die of disease or other factors – indeed, GH coho have been observed to have reduced resistance to bacterial pathogens (Jhingan *et al.* 2003). Uncertainties in these GH coho parameter values were later employed in Monte Carlo simulations.

In the absence of field studies, we hedged uncertainty by creating four different possible diets for GH coho, including a baseline assumption of the same diet as resident salmon. For the other diets, we assumed that GH coho are pure opportunistic predators, i.e., diet is directly proportional to the biomass of organisms selected as prey (this is automatically driven by the Ecosim model as selected prey biomass changes). The three possible diets differ in the selected potential prey the GH coho may feed on. For the forage diet, we assume that GH coho feed on forage fish and invertebrates. For the forage hake diet, we assume that GH coho also feed on hake in addition to the forage diet. For the broad diet, we assume a diet of only 20% demersal fish, given that GH coho, like their wild counterparts are more likely to encounter pelagic organisms and invertebrates.

We assume that GH coho have the same predators as resident salmon, but with increased risk of predation because they tend to position themselves closer to the surface (Sundström *et al.* 2003) and because they have reduced swimming ability (Farrell *et al.* 1997; Lee *et al.* 2003) and brain and eye structure changes (Devlin *et al.* 2012; Kotrschal *et al.* 2012). Some lab-based semi-natural habitat experiments have revealed higher predation mortality in GH coho than in their counterparts (Sundström *et al.* 2004; Sundström *et al.* 2005). Therefore, we assume GH coho have a 50% higher predation mortality than resident salmon to bigger predators such as harbour seals. We also apply lower predation mortality for GH coho to small predators such as birds, due to their difficulty in handling big prey. We found a small proportion of resident salmon in the adult pollock diet in Li *et al.* (2010) based on Preikshot (2007). However, salmon do not contribute to the diet of adult pollock in the Puget Sound (Harvey *et al.* 2010), Northern BC (Ainsworth 2006), or Alaska (Yang & Nelson 1999). We therefore corrected this by replacing the salmon’s proportion with euphausiids in the adult Pollock diet. Additionally, we applied the same low fishing mortality (mainly the recreational fishery) for GH coho as the resident salmon (Li *et al.* 2010).

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