ID:1715

Marlborough Salmon Farm Relocation Advisory Panel

Dear Peter Skelton,

REVIEW OF ASSESSMENT OF EFFECTS ON KING SHAG PREY

I have read and agree to comply with the Environment Court of New Zealand Code of Conduct for expert witnesses 2014.

The Ministry for Primary Industries (MPI) requested that I review the assessment by Paul Taylor (2016) regarding effects of salmon farming on the prey of King Shags. The purpose of the review was to estimate the point during the seabed recovery trajectory of fallowed sites, where they are likely to become feeding grounds for common king shag prey species. My assessment was based on the findings of a recent study by Keeley *et al.* (2015), where seabed recovery was monitored beneath fallowed salmon farm sites in the Marlborough Sounds.

After reviewing the evidence prepared by submitters, I have listed below points of agreement and disagreement relating specifically to the seabed recovery of fallowed or vacated farm sites and the timing at which king shag prey species are likely to return to these sites.

Points that I agree with opposing experts:

Schuckard (Points 51-53): I agree that polychaete worms are important bioturbators in the marine environment.

Fisher (127): I agree with the statement that the exact time to full recovery is unknown. However, I would like to reiterate that we have a good understanding of the recovery trajectory of infauna and the presence of epifauna at fallowed sites, so we have some certainty around when prey for fish species will be present. The assemblages of species within and on the seabed at vacated farm sites is likely to differ from reference sites for more than 24 months (Keeley *et al.* 2015), but that does not mean that fish prey species will not be present. Immediately after pens are removed, the epifauna and fouling species that fall from the farm structures and form a halo around the farm are likely to provide feeding grounds for many fish species that are part of the diet of king shags. Directly under the fallowed farm area, the abundance of infauna (including polychaete worms), which are known prey items for fish species that form part of the King Shag diet, has been found to increase greatly within 6 months after pens are removed (Keeley *et al*. 2015). From 6-12 months, polychaete worms become highly abundant at fallowed low-flow farm sites as they process the organic matter and oxygenate the seabed through bioturbation.

Points that I differ in opinion from opposing experts:

Schuckard (Point 54): It appears that Mr Schuckard is trying to make the point that polychaete worm abundance decreases beneath salmon farms, in particular he references the abundance of maldanid polychaetes beneath a mussel farm.

Schuckard (Point 97): Mr Schuckard appears to be suggesting that the recovery of the benthic infauna communities beneath fallowed sites would compromise the abundance of prey items for fish species for more than five years.

The reasons why my view should be preferred over the opposing experts:

Schuckard (Point 54 & 97):

Cawthon Institute has been monitoring seabed communities beneath salmon farm sites in the Marlborough Sounds for over 20 years. We have also published studies on international journals on the recovery of seabed communities beneath fallowed farms sites.

I acknowledge that the infaunal and epifaunal species assemblages will change under and in the immediate vicinity of fallowed salmon farms sites. However, I do not agree that fish prey species abundance would be compromised relative to reference sites. While some species of polychaete worms are less tolerant of organic enrichment, other species of polychaetes, in particular those belonging to the Capitellidae and Dorvilleidae families, often increase in abundance beneath and in the immediate vicinity of salmon farms, particularly at higher flow sites. At salmon farms in the Marlborough Sounds, the abundance, diversity, and functional groupings of infauna, including polychaete worms, are used as an integral part of the enrichment stage (ES) index (Keeley *et al.* 2012; Keeley *et al.* 2013; Keeley *et al.* 2014). The ES index is used to manage benthic effects at salmon farms for resource consent monitoring and also to the track the recovery of the seabed after fallowing (e.g. Keeley *et al*. 2015). Depending on how the farm has been managed in the years leading up to fallowing, the abundance of polychaete worms can range from greatly increased (1000 to 2500 per seabed sample) to very low (1 to 2 per sample). The infauna and epifauna assemblages that surround fallowed sites, and play a key role in the recovery trajectory of these sites, include species known to form a significant part of the diet of many fish species that are common prey for king shags. Even at sites where polychaete abundance is very low at the time of fallowing, fish species are likely to return immediately, as we frequently observe these fish at the edge of farm pens during environmental monitoring.

Yours sincerely

Dr David Taylor
Coastal Marine Ecologist
Aquaculture Monitoring Team Leader
Cawthron Institute

References:

Keeley N, Forrest B, Crawford C, Macleod C 2012. Exploiting salmon farm benthic enrichment gradients to evaluate the regional performance of biotic indices and environmental indicators. Ecological Indicators 23: 453-466.

Keeley N, Forrest B, MacLeod C 2013. Novel observations of benthic enrichment in contrasting flow regimes with implications marine farm management. Marine Pollution Bulletin 66: 105-116.

Keeley NB, Forrest BM, Macleod CK 2015. Benthic recovery and re-impact responses from salmon farm enrichment: Implications for farm management. Aquaculture 435: 412-423.

Keeley NB, Macleod CK, Hopkins GA, Forrest BM 2014. Spatial and temporal dynamics in macrobenthos during recovery from salmon farm induced organic enrichment: When is recovery complete? Marine Pollution Bulletin 80 (1–2): 250-262.

Taylor PR 2016. Effects of salmon farming in the Marlborough Sounds on the prey of king shag, *Leucocarbo carunculatus*. Report prepared for NZ King Salmon by Statfishtics, Hamilton. 10 p.