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Salmon Diseases Connectivity between Fish Farm Management Areas in Chile

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Abstract : Since 1980's aquaculture has become the biggest economic activity in southern Chile, being Salmo salar and Oncorhynchus mykiss the main finfish species. High fish density makes both species prone to contract diseases, what drives the industry to big losses, affecting greatly the local economy. Three are the most concerning infective agents, the infectious salmon anemia virus (ISAv), the bacteria Piscirickettsia salmonis and the copepod Caligus rogercresseyi. To regulate the industry the government arranged the salmon farms within management areas named as barrios, which coordinate the fallowing periods and antibiotics treatments of their salmon farms. In turn, barrios are gathered into larger management areas, named as macrozonas whose purpose is to minimize the risk of disease transmission between them and to enclose the outbreaks within their boundaries. However, disease outbreaks still happen and transmission to neighbor sites enlarges the initial event. Salmon disease agents are mostly transported passively by local currents. Thus, to understand how transmission occurs it must be firstly studied the physical environment. In Chile, salmon farming takes place in the inner seas of the southernmost regions of western Patagonia, between 41.5ºS-55ºS. This coastal marine system is characterised by western winds, latitudinally modulated by the position of the South-Eats Pacific high-pressure centre, high precipitation rates and freshwater inflows from the numerous glaciers (including the largest ice cap out of Antarctic and Greenland). All of these forcings meet in a complex bathymetry and coastline system - deep fjords, shallow sills, narrow straits, channels, archipelagos, inlets, and isolated inner seas- driving an estuarine circulation (fast outflows westwards on surface and slow deeper inflows eastwards). Such a complex system is modelled on the numerical model MIKE3, upon whose 3D current fields particle-track-biological models (one for each infective agent) are decoupled. Each agent biology is parameterized by functions for maturation and mortality (reproduction not included). Such parameterizations are depending upon environmental factors, like temperature and salinity, so their lifespan will depend upon the environmental conditions those virtual agents encounter on their way while passively transported. CLIC (Connectivity-Langrangian–IFOP-Chile) is a service platform that supports the graphical visualization of the connectivity matrices calculated from the particle trajectories files resultant of the particle-track-biological models. On CLIC users can select, from a high-resolution grid (~1km), the areas the connectivity will be calculated between them. These areas can be barrios and macrozonas. Users also can select what nodes of these areas are allowed to release and scatter particles from, depth and frequency of the initial particle release, climatic scenario (winter/summer) and type of particle (ISAv, Piscirickettsia salmonis, Caligus rogercresseyi plus an option for lifeless particles). Results include probabilities downstream (where the particles go) and upstream (where the particles come from), particle age and vertical distribution, all of them aiming to understand how currently connectivity works to eventually propose a minimum risk zonation for aquaculture purpose. Preliminary results in Chiloe inner sea shows that the risk depends not only upon dynamic conditions but upon barrios location with respect to their neighbors.

Keywords : aquaculture zonation, Caligus rogercresseyi, Chilean Patagonia, coastal oceanography, connectivity, infectious salmon anemia virus, Piscirickettsia salmonis
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