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Are new industry policies precautionary? The case of salmon aquaculture siting policy in British Columbia

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ABSTRACT

This paper argues that regulatory processes and outcomes in the context of a new industry could respond to mechanisms and factors that shape governmental agendas, illustrating how policy can behave reactively rather than in a precautionary manner. In the case of salmon aquaculture, an emerging industry characterized by risks, uncertainties, exponential growth, economic significance and environmental controversy, the outcomes of such reactive policies are generally reflected in siting criteria that yield implicit environmental and socio-economic disadvantages and trade-offs. This paper proposes a conceptual framework based on specific mechanisms and factors that attempt to explain how policy evolves in the context of a new industry. It then links regulatory events back to the concepts to discuss how siting policy has been shaped using the salmon aquaculture industry in British Columbia as an example. The paper finally argues that, although in practice, policy makers generally tend to make incremental choices that are reactive to diverse issues, new industries could adopt more precautionary policies based on processes of public negotiation, analytical decision making and regional planning based on a systems approach.

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1. Introduction

Industry sectors that face multiple risks and public opposition frequently have to comply with strict and complex regulatory outcomes. A good example is the case of new industries that need to site 'undesirable' facilities to carry out their everyday operations. Siting policy choices for these industries are often complex, as regulatory processes need to consider significant social and environmental aspects while being able to deal with conflicting interests and values that generate disagreements among stakeholders and policy makers. Siting cases such as energy facilities (Van der Horst, 2007; Keeney, 1980), hazardous facilities (Kunreuther et al., 1993) and solid waste landfills (Al-Yaqout et al., 2002) often end up in controversial

affairs, where businesses and municipalities are sometimes confronted by local interest groups and regulators. More recently, newer industries such as salmon aquaculture have begun to face similar siting issues, which are characterized by a profound interaction between biophysical, socio-economic, political, and cultural-ethical contexts.

To date, siting undesirable facilities continues to raise intense public resistance, mainly due to potential health and environmental concerns. In their need for policy regulation, some of these industries have adopted a common practice to react to external events rather than behaving in a precautionary manner (that is, attempting to balance environmental, socio-economic and governance goals), thereby missing the opportunity to promote policies aimed at protecting human

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health and the environment in the face of uncertain risks (Kriebel et al., 2001). The precautionary principle is advocated widely as a basis for regulatory decisions regarding risks whose extent and potential consequences are not well understood (O'Riordan and Cameron, 1994). Yet, in practice, there are many instances in which new risks are not approached with precaution.

Salmon aquaculture is an example of a new industry where multiple risks and uncertainties, exponential growth and an intense environmental debate tend to drive policy makers to expand, adjust or replace siting policy in the need for changing regulations in short time frames. Siting policy has become central to the debate over the conflicts and concerns regarding the salmon aquaculture industry in different parts of the world. In British Columbia (BC), criteria for site selection ultimately determine the location of salmon aquaculture facilities and shape siting policy processes and outcomes. However, the way that such criteria are determined and what they entail render several disadvantages and trade-offs that may certainly limit the expansion of the sector (under the assumption that salmon aquaculture is a viable industry that is capable of further growth). The development of the industry in the province has also generated social and environmental controversy as fish farm sites and their ecological footprint commonly interfere with the way of life of indigenous (First Nations) groups (Gerwing and McDaniels, 2006), coastal communities and other resource users, some of whom are in opposition to industrial aquaculture. As far as siting policy is concerned, this fact makes the BC case distinctive from several other aquaculture-intensive jurisdictions.

Salmon aquaculture was introduced to BC in the 1970s, albeit in small-scale, locally controlled farms (Keller and Leslie, 1996). During that same decade, Norway and Scotland took the lead in commercial, large-scale salmon production. BC's salmon farming industry continued to expand during the next two decades under a very complex regulatory setting (Galland, 2004). The industry developed extensively in Chile and, to a lesser degree, in the Faeroe Islands and Eastern Canada. As of 2008, BC is the world's fourth largest farmed salmon producer (British Columbia Salmon Farmer's Association, 2008), although its magnitude remains relatively small compared to the global industry, in that Norway and Chile together represent about 80% of the worldwide farmed salmonid production (Food and Agriculture Organization, 2008).

This paper addresses (i) the way by which siting regulatory processes associated with the salmon aquaculture industry in BC have evolved, (ii) the implications that reactive regulatory outcomes could yield, and (iii) how facility siting could benefit from other potential processes toward the adoption of more precautionary policy. Section 2 outlines concepts relevant for understanding the evolution of policy and discusses the dynamics that occur between them to illustrate that policy is commonly shaped on a reactive basis. Section 3 introduces the context of salmon aquaculture facility siting putting emphasis on the social and environmental dimensions in which the industry is embedded. Next it outlines the nature of the regulatory framework for the salmon aquaculture industry in BC. Section 4 explores the factors that have influenced the

evolution of salmon aquaculture facility siting policy and discusses its disadvantages and trade-offs. Section 5 suggests three potential processes associated with facility siting that could benefit the salmon aquaculture industry toward the generation of more precautionary policy. The final section links the facility siting policy case back to the conceptual framework and provides conclusions.

2. Concepts for understanding the evolution of policy

How does policy generally evolve in the context of a new industry? This question arises from the need to understand the factors by which siting policy processes and outcomes were shaped in BC's salmon aquaculture case, where initial planning approaches neither projected an accelerated expansion nor conceived significant potential risks (which were almost unknown in the province at the time when the industry was first established there). In BC, siting salmon aquaculture facilities has been a controversial resource management issue at least since the 1980s. The federal and provincial governments introduced siting policy several years after the industry was established and during a process of rapid expansion. Siting fish farms became gradually more complex as numerous stakeholders reacted to this process. To date, there is no harmonization of siting criteria between policy makers or agreement between stakeholders about their meaning. It is expected that examining the factors that shaped such policy will contribute to offer insights for future policy decisions and to understand the rationales, disadvantages and implicit trade-offs behind their establishment.

This section suggests a theoretical framework based on a set of proposed mechanisms and factors that attempt to give an answer to the question suggested above. We develop this framework under the theoretical basis of governmental agenda setting, which describes how problems come to be addressed from a policy perspective (Kingdon, 1995). In addition, we make use of inductive reasoning to strengthen this framework by determining additional concepts. In doing so, we first performed a thorough literature review and analysis concerned with relevant siting policy documents (the most important being the Salmon Aquaculture Review, published by British Columbia's Environmental Assessment Office in 1997) and conducted a number of interviews (with government officials of the federal Department of Fisheries and Oceans and the provincial Ministry of Agriculture, Food and Fisheries, as well as individuals associated with research organizations and the industry itself). These interviews contributed to expand on the previous review and helped clarify the origin, evolution, purpose and rationale behind siting policy. The interviews were also thought to yield relevant information regarding actual siting policy outcomes. This fact contributed to shape the concepts associated with the theoretical framework.

The main argument of this framework asserts that regulatory processes and outcomes in the context of new industries may respond to factors that shape governmental agendas. This response ultimately illustrates how policy can behave reactively rather than in a precautionary manner.

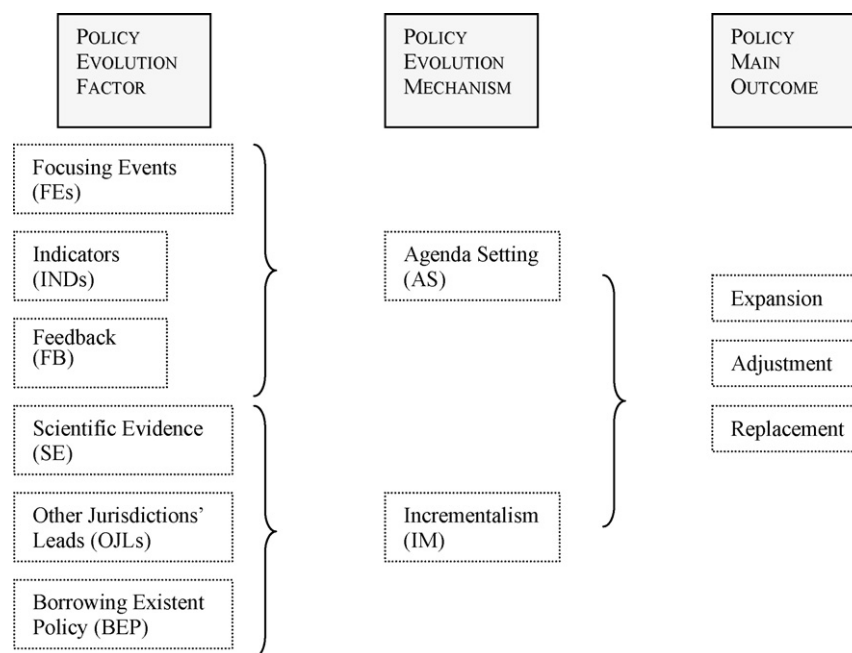


Fig. 1 – Framework explaining the factors that may influence the evolution of policy in new industries.

2.1. Factors that influence the evolution of policy

We argue that policy evolution in the context of new industries could be founded on two mechanisms: agenda setting and incrementalism. Each mechanism is a function of three different and independent factors. Governmental agenda setting is a function of focusing events, indicators and feedback. The dynamics of these three factors depend on environmental, socio-economic or political issues and have the potential to create and constantly shape policy outcomes in the form of guidelines, criteria or regulations. Incrementalism is a function of scientific evidence, other jurisdictions' leads and borrowing existing policy. Altogether, these six policy evolution factors may influence policy independently or in a combined way via expansion, adjustment or replacement of existing policy (Fig. 1).¹

2.1.1. Agenda setting

A given governmental agenda is the list of matters to which officials pay attention at any particular time (Kingdon, 1995). These agendas are usually established by participants and processes, which together determine how and why subjects take precedence among each other on an agenda. Kingdon suggests that three processes determine how prominent a

matter is on a specific agenda: the recognition of problems, the occurrence of political events and the involvement of visible participants. The recognition of problems depends on how participants (from inside or outside the government) learn about them, which can occur via focusing events, indicators and feedback. The first part of our framework adopts these three factors associated with Kingdon's first agenda setting process in attempting to explain the evolution of policy.

Focusing events are associated with happenings inside or outside a specific industry that are concerned with the industry itself and that may have the potential to impact its policy processes. Disasters and crises are typically focusing events. These two phenomena are often interconnected. Disasters usually take place during a short period of time whereas crises last longer, sometimes as a result of a disaster. In other words, the consequences of a disaster may give rise to a crisis. However, this process may also occur the other way around. For instance, a crisis may not be regarded as such until it turns into a disaster.

Indicators describe the magnitude or show change in a particular condition: the larger the magnitude or change, the higher the probability to attract participant attention and therefore to influence policy. Indicators can comprise both qualitative and quantitative values, such as the occurrence (or frequency) of a particular disease or the cost of a facility or program. Indicators are inherently interconnected with focusing events and feedback in the sense that they reflect an objective measure of the former and are prone to subjective constructs regarding the latter.

Feedback simply refers to formal or informal means by which officials come to know about a specific problem or condition. Formal means involve specific assessments, evaluations or studies. Informal means could be 'streams of complaints' from specific stakeholders. Just as indicators sometimes depend on feedback constructs, indicators may

¹ The first part of this framework (comprised by the definitions and explanations associated with focusing events, indicators and feedback) is entirely drawn from Kingdon (1995). Also, it should be noted that, in principle, all factors are ultimately associated with agenda setting. Besides focusing events, indicators and feedback, the factors associated with incrementalism also have the potential to influence agenda setting in a direct way. In other words, the progressive incremental growth of policy itself may well have been originated via agenda setting. However, for the purpose of this analysis and to offer a clearer emphasis, all factors are addressed separately.

also importantly influence feedback. The combination of both factors can determine the level of significance of a focusing event.

2.1.2. Incrementalism

Incrementalism makes reference to changes associated with existing policy that proceed gradually via independent factors during a specific period of time. In other words, incrementalism is a mechanism of progressive policy growth. Kingdon (1995) suggests that incrementalism occurs when policy makers generate small, incremental, marginal adjustments to existing policy. Based on this premise, we argue that the incrementalism mechanism could be triggered via three-independent factors: scientific evidence, other jurisdictions' leads and borrowing existing policy. As it occurs with agenda setting factors, any of these three incrementalism factors (which together comprise the second part of our proposed framework) may have the potential to shape policy via expansion, adjustment or replacement.

Scientific evidence encompasses the products of research in a given field. It is via this factor that the scientific community plays an indirect role on public policy-making. Scientific evidence may influence the expansion, adjustment or replacement of policy by providing qualitative or quantitative indicators. For instance, a significant scientific discovery is capable of generating a strong policy response if a specific 'policy window' is open at that moment. The way in which a jurisdiction reacts to a scientific discovery may vary according to the interaction of ideas, domestic interests and political institutions associated with the jurisdiction. Ideas demand either severe or weak measures that lead to policy change. Interests are mainly driven by economic goals, which interact with ideas. Finally, political institutions ultimately determine the relevance of scientific research according to existing legislation and regulatory history (Harrison, 2002).

Following other jurisdictions' leads may be considered (in some instances) a feasible and timesaving approach to developing policy, particularly when a jurisdiction is largely unfamiliar with a new industry. The global expansion of markets has helped establish industries in new regions that may not be familiar with them. This phenomenon creates the need for new regulations. Adopting or adapting the regulatory leads from other jurisdictions where an industry has existed longer could therefore be convenient. Adoption could be seen as the straightforward acceptance and implementation of another jurisdiction's policy. Adaptation, however, is a process of framing, shaping or moulding policy according to a jurisdiction's own biophysical, socio-economic and political systems. In principle, the adoption of regulatory standards may bring about significant risks as systems are never identical in two jurisdictions. Adapting policy according to specific biophysical, socio-economic and institutional spheres may be more sensible.

Finally, borrowing existing policy occurs when new industries borrow existent policy from a different industry or public agency when they lack a solid policy structure or when they must comply with policies that affect other industries. This factor may be a function of the relationship between different industries in terms of activities or biophysical locations, especially when they must share resources to

carry out their activities (e.g., fisheries and aquaculture). We have inductively developed the borrowing of existing policy factor based on this particular case study.

2.2. Dynamics between policy evolution factors

In accordance with the conceptual framework that we developed, the evolution of policy associated with a new industry is activated by some environmental, socio-economic or political issue (or a combination of these). The recognition of such issues may occur in the form of focusing events (e.g., an environmental disaster or socio-economic crisis). Indicators are the elements that show the magnitude of the event and are objective manifestations of focusing events. Finally, feedback, which may be a stream of complaints from stakeholders, is a subjective manifestation of focusing events. The dynamics that occur among these three factors have the potential to shape policy in the form of expansion, adjustment or replacement. The three factors associated with the incrementalism mechanism (i.e., scientific evidence, other jurisdictions' leads and borrowing existing policy) also have the potential to modify existing policy but on an individual basis (i.e., they are not interconnected as in the case of agenda setting factors but may work to create similar outcomes). These factors may also trigger the creation of policy in combination with agenda setting factors or by themselves (Fig. 2).

3. The context of salmon aquaculture facility siting in British Columbia

3.1. Dimensions of facility siting

Where aquaculture facilities are to be located is a deeply complex and controversial question in British Columbia. Locations preferred for salmon aquaculture tend to be

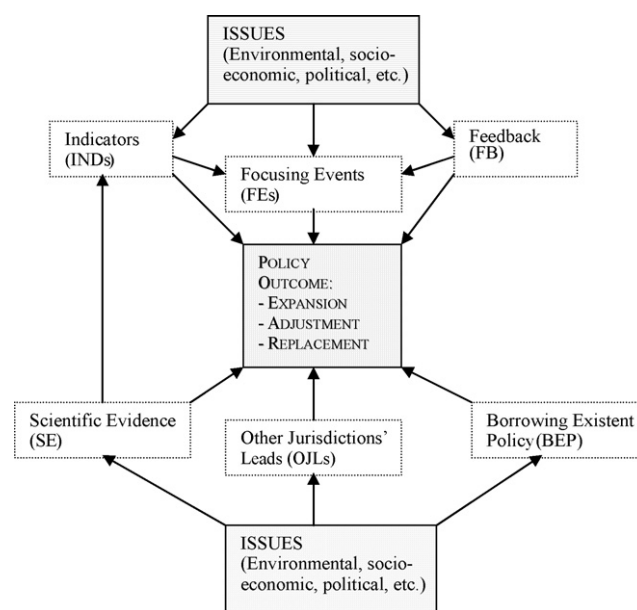


Fig. 2 – Dynamics that may occur between policy evolution factors in the context of new industries.

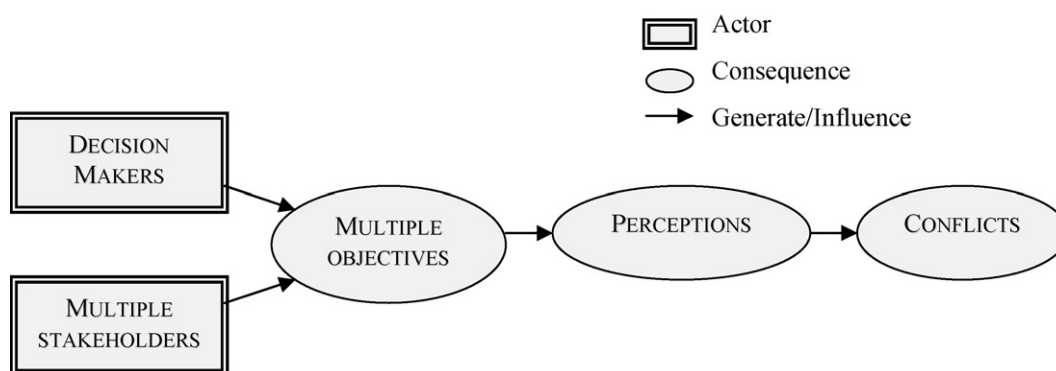


Fig. 3 – Siting controversial facilities: the social dimension.

pristine, remote, sheltered, have deep water and are often in areas of high ecological productivity. Hence it is not surprising that siting such facilities has become perhaps the most contested aspect of the regulatory process. A broad review of societal concerns regarding aquaculture in British Columbia is provided in Leggatt (2001). An analytical approach to understanding conflict in the salmon aquaculture industry generally is provided in Noakes et al. (2003). Perhaps the most adversely affected groups that cope with salmon aquaculture are First Nations (aboriginal) communities with small reserves that are often close to aquaculture sites. Concerns and values of First Nations groups that must live with aquaculture are discussed in detail in Gerwing and McDaniels (2006). Aquaculture is also seen by many as a source of risk to environmental resources from a variety of steps and components in the production process (McDaniels et al., 2006a). Clearly, siting aquaculture facilities is just one level of governance and regulation in multiple-scale management concerns that extend from local to global levels, and requires integration across scales of governance (McDaniels et al., 2005, 2006b). The global implications of increasing reliance on aquaculture generally, of which salmon is a major share, are discussed in Naylor et al. (2000).

Siting refers to the process of identifying and selecting areas that are economically, socially and environmentally suitable to locate certain types of facilities. Facility siting is an exceptionally complex problem associated with new and controversial industries such as salmon aquaculture. The process involves high-stakes decisions but there is a lack of expertise among stakeholders and policy makers that can lead to different interpretations and difficult understanding of such concerns (i.e., the interaction of environmental, socio-economic, political and cultural contexts associated with the industry). The focus on environmental, social and economic performance within governance processes involving stakeholders indicates that siting aquaculture facilities is one example of the broader challenge of sustainability, particularly in rural locations. The writing on issues of sustainability is vast and cannot be addressed thoroughly here. Owens and Cowell (2002) provide a clear summary of sustainability in land use contexts. While we are referring to a water-use activity, the basic concepts outlined by Owens and Cowell apply here as well.

Facility siting became controversial since the 1970s with cases associated with chemical and nuclear power plants, landfills and incinerators, among others. To date, siting these types of facilities continues to raise intense opposition due to potential health and environmental concerns as the general public has become increasingly aware of the inherent risks and uncertainties associated with them. Similarly, communities have grown more sceptical of government authorities and industry when it comes to site undesirable facilities. Disagreements about values and objectives inevitably arise and considerable challenges to enhance siting processes remain.

To illustrate this situation, we delve into the social and environmental dimensions that characterize the facility siting process. The interconnections of the aspects that comprise both dimensions are essential to understand the roots of facility siting issues in the case of new industries.²

3.1.1. The social dimension

Significant social aspects are inherently associated with siting contentious types of facilities such as hazardous waste deposits, nuclear power plants, and more recently, marine-based aquaculture facilities. Such aspects may be associated with multiple stakeholders and objectives, risk perceptions, concerns, uncertainties about impacts and intangibles. Their degree of relevance may be considered a function of the site in question.

Multiple stakeholders imply multiple objectives that have the potential to influence siting decision-making processes (Fig. 3). For instance, stakeholders may involve federal, provincial and local governments, industry, research organizations, First Nations groups, communities, other resource users, and the general public, among others. Each party has its own set of values and interests, which translate into different objectives. In siting, stakeholders could be divided into proponents and opponents. All stakeholders have fundamental objectives that are a function of their values and interests, as well as their socio-economic, political and

² Keeney (1980) proposes and thoroughly discusses the aspects of these dimensions for the case of energy facilities. We have adapted these aspects for the case of marine-based salmon aquaculture facilities.

environmental conditions. For instance, the fundamental objectives of site proponents (e.g., a federal government agency, an industry, or a provincial government) could ultimately relate to economic revenues and jobs. At the same time, the fundamental objectives of site opponents (e.g., a local community, a municipal government, or an environmental interest group) could focus on short and long-term health impacts, aesthetics, reduced property values and risk concerns. Industry objectives may strongly influence the desirability of a site while the degree of impacts, risks and uncertainties inherent to site operations could shape the objectives of stakeholders who are opposed.

A site's value to a stakeholder is a function of his fundamental objectives, which may clearly be opposed to other stakeholder objectives. Deciding which objectives will take priority during the decision-making process and final outcomes is an issue. Value trade-offs are unavoidable. Based on this premise, it is essential to minimize and balance such trade-offs during and after the facility siting process.

To determine trade-offs and regulatory disadvantages, a multiple-objective stakeholder scenario is necessary, although it also inevitably gives way to diverse perceptions of risks and uncertainties, which generate different attitudes. Stigma, an extreme case of perceived risk, illustrates the enormous differences in perspective that may exist among stakeholders (Gregory et al., 1996). In siting controversial facilities, stigma can be associated with the operations or purpose of the site.

Another aspect of the social dimension of siting is the uncertainty associated with the impacts that a particular site could generate. The prediction of phenomena associated with future implications of sites could be inaccurate. An open approach towards uncertainty could allow stakeholders to consider the most and least important factors and sources of disagreement in a problem, and to plan for probable unexpected events. Historically, decision-making processes associated with new industrial sectors have considerably disregarded uncertainties. Identifying and effectively addressing them is essential to minimize health and environmental concerns.

Finally, there is the question of intangibles. Socio-economic objectives can indeed be measured in defined units like jobs or dollars. However, other aspects are difficult to measure in tangible terms. These may include the social disruption of psychological and moral impacts on local or nearby communities, or the aesthetic disruption of sceneries.

3.1.2. *The environmental dimension*

The environmental dimension of the facility-siting problem is comprised by two major issues. The first one relates to searching for locations that are environmentally suitable for the facility's own purposes, that is, the appropriate biophysical and spatial considerations that make the site a suitable location. The second issue is the potential for impacts on the ecosystems where the facility is located. In practical terms, this can be addressed with environmental impact assessments or studies that are designed to identify and predict impacts on the biophysical environment, human health and well being, and to interpret and communicate information about the impacts.

Identifying an environmentally suitable location is a crucial step in the facility siting process. First, a region (e.g., an inlet, for salmon aquaculture purposes) is chosen. Next, numerous potential sites give way to a final selection. Several biophysical criteria need to be met. For instance, proponents of an energy facility may consider environmental variables such as topography, climatic conditions, wind directions, and so forth. Similarly, proponents of a waste disposal facility must regard water levels and soil composition, among other environmental variables. Proponents of a marine-based aquaculture facility may be concerned with water temperatures and currents, dissolved oxygen levels, depth and site physiography, hydrology, salinity, and interactions with flora and fauna, among others (Ministry of Agriculture, Food and Fisheries, 1987). These factors are measured to determine the viability of a site and to give information to explore the impacts that it may have on biophysical systems.

The potential impacts that sites may cause on ecosystems are typically addressed via environmental impact assessments that incorporate risks and uncertainties. Numerous ecological considerations that consider the influences and interactions between organisms should be addressed. This is particularly important in the case of marine-based aquaculture facilities (also called net-pens or fish farms), which are usually in direct contact with the environment. It is difficult to predict how other systems will respond to aquaculture disturbance gradients that extend beyond the net-pen structure. On this view, sites could be considered as elements of complex systems that are interconnected and influence one another, as we will discuss further in Section 5.

Environmental risks are commonly associated with fish health and impacts on the surrounding biophysical environment. These include genetic damage to wild stocks, fish escapes, exotic diseases introduced by imported Atlantic salmon eggs, and waste discharges (British Columbia Environmental Assessment Office, 1997). Human health risks arise from the consumption of both wild and farmed fish. For instance, wild salmon may be under risk of infectious diseases that could be passed on to humans. Similarly, farmed fish could contain antimicrobial drug residues that could inflict health risks to consumers (Ellis, 1996; Leggatt, 2001).

3.2. *Salmon aquaculture regulatory framework*

BC's salmon aquaculture industry began to operate in the 1970s. Since then, the industry has faced an unclear identification of regulatory responsibilities and little policy guidance. From the mid-1980s, the industry has faced thorough competition with other existing resource users (i.e., the fisheries and tourism industries, and local communities), which generally leads to conflict and distrust. At the same time, insufficient consideration was allocated to potential impacts related to environmental values. Farm practices generally improved over the years, but the absence of clear standards, consistent performance, strict enforcement of regulatory requirements and meaningful public participation in siting decisions have continued to generate criticism.

Table 1 – Evolution of salmon aquaculture (siting) policy in British Columbia^a

Regulatory event	Siting objectives	Reactive to
(a) DFO Siting Guidelines	To prevent impacts on fish To avoid resource user conflicts	FEs, INDS, FB, BEP
(b) Gillespie Inquiry (1986)	To avoid resource user conflicts	FEs, INDS, FB (OJLs)
(c) MAFF Biophysical Siting Criteria (1987)	To address environmental suitability	SE (FEs, INDS, FB)
(d) Ombudsman Report (1988)	To mediate resource user conflicts	FB
(e) DFO Aquaculture Report (1988)	To address resource user conflicts	FB
(f) Memorandum of Understanding (1988)	To define positions between levels of government	FB
(g) Biophysical Suitability Studies (1989)	To determine attributes and natural adversities of the environment for siting facilities	AS, IM
(h) Coastal Resource Interest Studies (1992)	To produce maps to show the areas suitable to site farms from the perspective of preventing conflicts with other resource users	IM
(i) Salmon Aquaculture Review (1997)	To locate salmon farms at sites with intrinsic biophysical capability and socio-cultural suitability to prevent or reduce negative impacts and conflicts	AS, IM FEs, INDS, FB, SE (OJLs)
(j) MAFF Aquaculture Management Plan (2000)	Same as SAR. Only applies to the siting of new tenures	IM
(k) Aquaculture Opportunity Studies (2002)	To support new siting and relocation of fish farms by identifying feasible “opportunity areas”	FB, IM
(l) Federal CEAA Screenings (2002)	To provide new precautionary measures for fish farm license approval	IM

^a Acronyms: AS, Agenda Setting; IM, Incrementalism; FEs, Focusing Events; INDS, Indicators; FB, Feedback; SE, Scientific Evidence; OJLs, Other Jurisdictions' Leads; BEP, Borrowing Existing Policy. The parenthesis () indicates that factors indirectly influenced the evolution of policy.

The industry is currently regulated by several provincial and federal bodies.³ Their respective roles often overlap and their responsibilities and regulations could be somewhat complex (British Columbia Environmental Assessment Office, 1997). The federal government has responsibility for the conservation and management of the fisheries resource and is the regulatory authority for farmed fish health, food safety and public health, conservation and protection of wild fish stocks and habitat, and navigational safety (Office of the Commissioner for Aquaculture Development, 2003). The lead federal agency is Fisheries and Oceans Canada (also known as Department of Fisheries and Oceans or DFO).

The province has authority for the development and management of the industry, including location, size and development of farm sites, reporting requirements and monitoring operations. It also has overall responsibility for issuing aquaculture operating licenses and leasing Crown land (Ministry of Agriculture, Food and Fisheries, 2000). The lead entities are the Ministry of Agriculture and Lands (formerly known as Ministry of Agriculture, Food and Fisheries or MAFF) and Front Counter BC (formerly known as Land and Water British Columbia Inc. or LWBC).

To establish new salmon aquaculture operations or relocate existing facilities, applicants must obtain an aquaculture license issued by MAFF in compliance with the Fisheries Act. A review process based on biophysical suitability and technical viability is then carried out by the provincial ministry. The license is valid for a 1-year period, with an option for renewal. The holder must comply with aquaculture development plans, rear certain kinds of species and consider sensible precautions to prevent escapes from the

facilities. License applications are also reviewed by DFO under the Canadian Environmental Assessment Act (CEAA) screenings (Fisheries and Oceans Canada, 2002). A license is given only with MAFF and DFO approval.

Furthermore, proponents need also apply to Front Counter BC for Crown land tenure under the Land Act since aquaculture operations make use of public aquatic resources. The review process considers riparian rights, navigation requirements, aboriginal interests and environmental and social concerns (Land and Water British Columbia, 2002). Besides being contingent on the approval of federal and provincial bodies, siting decisions also depend on local governments who regulate local land use via zoning (Queen's Printer, 2003).

4. Evolution of facility siting policy and its implications

4.1. Factors that influence the evolution of salmon aquaculture siting policy

The proposed mechanisms and factors examined in Section 2 conceptualize the single or combined ways by which policy associated with a new industry may reactively evolve over time. This section uses the salmon aquaculture industry in BC as an example to illustrate the suggested framework. As discussed, salmon aquaculture has generated conflict and controversy in the province at least since the mid-1980s. Great part of the issue is due to the fact that the industry began to operate without a defined planning agenda that would deliver appropriate siting recommendations. Since then, salmon aquaculture has been subject to numerous reactive policy shifts that have geared the siting topic.

The evolution of salmon aquaculture siting policy in BC may be better understood through the identification and

³ For a more detailed description concerning the multiple levels (local, regional, national and international) at which the salmon aquaculture industry is regulated, see McDaniels et al. (2006a,b).

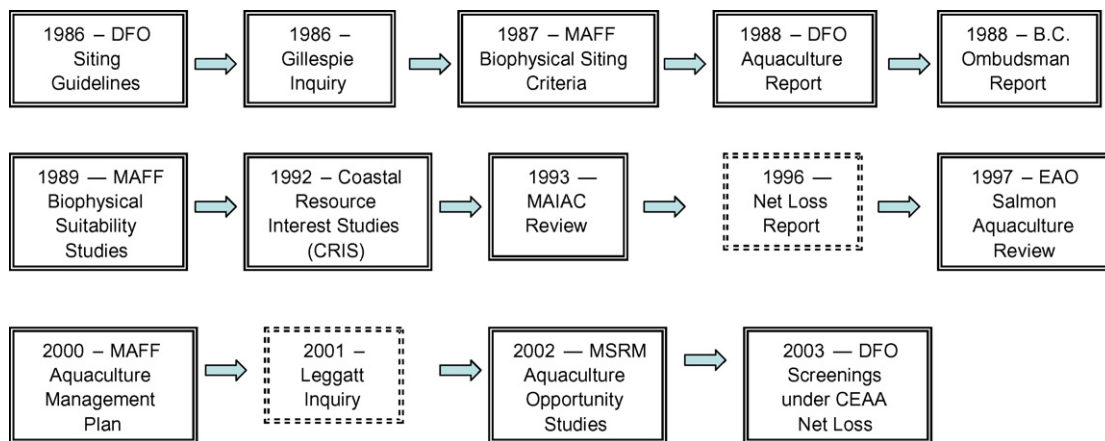


Fig. 4 – Chronology of studies, reviews, inquiries and reports that have influenced siting matters (including siting criteria, guidelines or recommendations) relevant to the salmon aquaculture industry in B.C.⁴

analysis of regulatory events that ultimately influenced siting decisions. Table 1 summarizes the overall objectives related to each regulatory event as well as the factors that could have influenced their development on a reactive basis. An explanation of the role that these factors played in shaping the origin and evolution of siting policy is offered in Sections 4.1.1 and 4.1.2.

Fig. 4 illustrates (in chronological order) the policy outcomes that directly or indirectly influenced salmon aquaculture siting matters in BC.

4.1.1. Factors that shape the origin of siting policy

In accordance with Table 1, regulatory event (a) gave origin to salmon aquaculture siting policy in BC. When the industry was first introduced to the province in the 1970s, salmon aquaculture was largely unregulated in terms of siting farms. In 1986, DFO developed a first set of guidelines that became the foundation for the further development of siting criteria (Fisheries and Oceans Canada, 1986). The agenda setting problem recognition process played a role in the origin of siting policy, which was originally issued in the form of guidelines (i.e., as recommendations that were not enforced). A combination of focusing events, indicators and feedback occurred simultaneously because the industry was rapidly expanding but ignoring potential environmental risks and uncertainties.

⁴ Bold and dotted textboxes refer to government and non-governmental documents, respectively. The only two documents that have been entirely devoted to siting regulation per se are the *DFO Siting Guidelines (1986)* and the *MAFF Biophysical Siting Criteria (1987)*, which together marked the origin of siting policy in the province. The rest have addressed the salmon aquaculture topic in general. The terms 'criterion', 'guideline' and 'recommendation' are different by definition. Criterion refers to a standard, rule, or test on which a judgement or decision can be based. A level of stringency is innately attached to this concept. On the other hand, a guideline is a statement aimed at determining a course of action, implying guidance without being compulsory. In the context of salmon aquaculture policy in B.C., MAFF has historically interpreted the three terms as 'guidelines', while DFO in B.C. regards them more as 'criteria'.

Focusing events unchained the problem recognition process to demand the generation of siting policy. A focusing event that attracted the attention of fishers, environmental interest groups and coastal communities was a massive bloom of phytoplankton that occurred in the coastal area where most salmon farms had been operating since the industry originated and began to expand, which generated the decline of marine wildlife in proximity to fish farms (Keller and Leslie, 1996). Another focusing event was illustrated by the increasing conflicts between resource users. Streams of complaints (a type of feedback) emerged from these two focusing events indicating a need for new siting policy. An important indicator was the loss of an estimated 100,000-farmed fish in a moment when little was known about the potential impacts of a large-scale aquaculture industry. Borrowing existing policy also played a minor role in shaping the initial siting policy document via the adoption of criteria that were borrowed from another public agency and applied to fish farm facilities (Tyedmers, 2000).

4.1.2. Factors that shape the evolution of siting policy

In accordance with Table 1, regulatory events (b) and (c) were the first signs of evolving policy. A stream of complaints from a coalition of critics (comprised mainly by fishers and community organizations) constituted the main source of feedback. These advocacy groups strongly opposed the introduction of Atlantic salmon and dreaded the impacts of fish farming on the benthic environment. Clearly, this feedback scenario along with its associated indicators was the reflection of a 'social crisis' that needed immediate attention. The use of other jurisdictions' leads in policy setting prior to regulatory event (b) brought about a high concentration of farms, creating unfamiliar risks that resulted in the aforementioned crises because the area's carrying capacity had been considerably surpassed.

The development of scientific evidence was the main factor that triggered the development of regulatory event (c). Until the release of these criteria, siting policy had merely focused on preventing impacts on fish and, more importantly, on avoiding user conflicts. The primary emphasis of siting policy had therefore been socially driven. With this

Table 2 – Criteria for siting new finfish aquaculture facilities (Ministry of Agriculture and Lands, 2007)

Proposals for new salmon farms must meet the following requirements and minimum separation distances. Sites must be located

1. At least 1 km in all directions from a First Nations reserve (unless consent is received from the First Nation)
2. At least 1 km from the mouth of a salmonid-bearing stream determined as significant in consultation with DFO and the province
3. At least 1 km from herring spawning areas designated as having “vital”, “major” or “high” importance
4. At least 300 m from inter-tidal shellfish beds that are exposed to water flow from a salmon farm and which have regular or traditional use by First Nations, recreational, or commercial fisheries
5. At least 125 m from all other wild shellfish beds and commercial shellfish growing operations
6. An appropriate distance from areas of “sensitive fish habitat”, as determined by DFO and the province
7. An appropriate distance from the areas used extensively by marine mammals, as determined by DFO and the province
8. At least 30 m from the edge of the approach channel to a small craft harbor, federal wharf or dock
9. At least 1 km from ecological reserves smaller than 1000 ha or approved proposals for ecological reserves smaller than 1000 ha
10. Not within a 1 km line of sight from existing federal, provincial or regional parks or marine protected areas (or approved proposals for these)
11. In order to not infringe on the riparian rights of an upland owner, without consent, for the term of the tenure licence
12. Not in areas that would pre-empt important Aboriginal, commercial or recreational fisheries as determined by the province in consultation with First Nations and DFO
13. Not in areas of cultural or heritage significance as determined in the Heritage Conservation Act
14. Consistent with approved local government bylaws for land use planning and zoning
15. At least 3 km from any existing finfish aquaculture site, or in accordance with a local area plan or Coastal Zone Management Plan

new regulation, a planning and a scientific approach were used together for the first time (Ministry of Agriculture, Food and Fisheries, 1987). This could have been a first example of precautionary action.

As in previous cases, Table 1 also shows that regulatory events (d), (e) and (f) occurred in response to feedback, although they mainly addressed resource use conflicts and government responsibilities that had little influence in siting decisions. Thereafter, incrementalism took place for the first time and allowed the next regulatory events (g) and (h) to occur. Although both events did not yield strict siting policy, they both contemplated siting objectives, built on previous reports and performed environmental and resource management research to determine guidance to allow for future siting criteria. Next, the need for scientific research due to environmental impacts and their multiple risks and uncertainties caused regulatory event (i) to happen, which was surely the most important and comprehensive policy event that had ever taken place concerning salmon aquaculture management in the province. Focusing events, indicators and feedback activated policy maker acknowledgement of serious environmental issues, which in essence were very similar (although perhaps not in magnitude) to those that had originated previous regulatory events. In addition to the agenda setting mechanism and its related factors, the incrementalism mechanism played a role in the incorporation of socio-economic considerations to existing siting policy, which had only regarded biophysical criteria. Scientific evidence and other jurisdictions' leads also played a minor role in the amendment of biophysical criteria.

More recent regulatory events (j), (k) and (l) were mostly a product of the incrementalism mechanism as well. However, regulatory event (j) was additionally driven by the ambiguity of former guidelines that had generated misunderstandings among the two levels of government and industry. Similarly, the forecasted lifting of the 1995 moratorium on farm leases (which did not occur until

September 2002) played an important role in the happening of this event.⁵

4.2. Implicit disadvantages of siting policy

Disadvantages refer to implicit inconveniences, conflicts or costs that may arise from the constitution and use of siting criteria. The types of disadvantages that emerge due to reactive policy are many. To begin, let us consider the most notable disadvantage of current siting policy: the exclusion of potentially suitable sites within a selected region. The main cause of this disadvantage could be credited to the use of *buffers* and *attributes* in siting criteria, which serve as means for separating fish farms from other biophysical settings or resource users. It is worth noting that 9 criteria out of a total of 15 are composed by buffers and attributes. We address the implicit disadvantages of buffers and attributes in the following two sections using one criterion as an example. Then, we delve into further disadvantages that emerge from site-specific criteria. Table 2 shows the 15 siting criteria for locating new salmon aquaculture facilities.

4.2.1. Buffers

Buffers divide a given region into acceptable and unacceptable areas, and thus have the feature of being both inclusive and exclusive. This implies that some areas become ‘inappropriate’ to site a facility whereas others turn into ‘appropriate’ zones. In this sense, buffers have the potential to exclude potentially suitable sites within a region of interest. To illustrate this argument let us consider the following criterion:

⁵ It is worth noting that siting criteria that resulted from this event have remained effective until 2007 and “take the place of any previous farm siting criteria, including (...) the Salmon Aquaculture Review’s recommended salmon farm siting criteria” (Ministry of Agriculture and Lands, 2007).

“A salmon aquaculture site must be located at least 1 km from the mouth of a salmonid-bearing stream...” (Ministry of Agriculture and Lands, 2007).

The buffer (1 km) in this criterion entails several downsides as explained in the following scenario: consider a hypothetical salmon aquaculture case in which site X adequately meets the remaining siting criteria (i.e., by large margins in the case of buffer-and-attribute siting criteria) but fails to meet this buffer by 20 m (i.e., site X is 980 m away from a salmonid-bearing stream). In another hypothetical case, site Y meets this and several other criteria but by very small margins of, say, 5 m (e.g., site Y is 1005 m away from a salmonid-bearing stream). The outcome of this scenario is that site X gets automatically eliminated whereas site Y is regarded as a ‘potential’ area to locate a facility. Considering that all 15 criteria are equally important, the outcome associated with site Y is clearly unfavourable as compared with site X. However, a less-desirable site is finally taken into consideration. A major implication associated with this scenario is that the less-desirable site (initially regarded as potential) is less likely to meet the multiple objectives sought by stakeholders and policy makers, and more likely to generate adverse impacts in the long run.

4.2.2. Attributes

Attributes are similarly fraught with disadvantages. The main reason is their ambiguity. Attributes are usually interpreted according to policy maker mandates or stakeholder interests and values. The attribute in the above scenario (i.e., salmonid-bearing stream) may be subject to multiple interpretations. For instance, DFO (a federal agency that has a fish protection mandate) considers any single stream or waterway regardless of its dimensions and fish population to be ‘salmon-bearing’. This implies that any stream bearing salmon or having the potential to bear salmon is taken into account even if there is no evidence of salmon habitat. In contrast, MAFF (a provincial agency that has an aquaculture development mandate) would only regard major waterways that bear a determined number of fish to be salmon-bearing streams. This implies that, depending on their interests and values, other stakeholders would either support DFO or MAFF. For instance, First Nations groups and the tourism industry (which are directly impacted by fish farms) would be likely to support DFO’s approach, while transnational corporations (which have interests to expand their operations in the region) would obviously agree with MAFF.

4.2.3. Site-specific criteria

A second implicit disadvantage of current siting policy is that site-specific criteria disregard biophysical and socio-economic cumulative impacts and thus hinder the integration of salmon aquaculture with region-smart plans (McDaniels et al., 2005). Siting criteria are site-specific in the sense that they implicitly identify particular ‘spots’ within a selected region where farms can operate while minimizing environmental impacts and resource user conflicts. However, the outcome of such criteria treats sites as independent components within vast systems, disregarding their dynamic interactions and emergent properties (Bavington, 2000). Following this logic, selected sites may

simply be used to pursue economic goals and be seen only as biophysical locations with the appropriate conditions to rear fish.

Furthermore, site-specific criteria cannot be conceived as part of an integrated regional planning approach. In BC, the regions where large concentration of farms exists have been physically divided into ‘blocks’. The reason behind this ‘block approach’ is that transnational corporations seek “ease of access and cost savings in serving the tenures with manpower and materials” (Ellis, 1996). This approach translates into economic savings and a more suitable fish farm management scheme because travel distances between fish farms and to processing and distribution centres are minimized. Nevertheless, blocks with a higher concentration of fish farms have a greater risk of adverse environmental impacts (e.g., on marine ecosystems and habitats) and social conflicts (e.g., with First Nations and other resource users). In addition, the use of blocks makes it more complex to coordinate the industry’s objectives with broader community economic development plans that seek to integrate the industry into the region. Cooperation and cohesion among industries are therefore made difficult when only one industry dominates an area.

Adverse impacts within a selected region commonly rise as the number of sites increase. In BC, the optimal biophysical conditions to grow fish associated with the selected blocks (the Broughton Archipelago and the Johnstone Strait) drove the industry to develop intensive aquaculture practices in multiple sites at a time when criteria had not been appropriately defined or implemented. Some environmental impacts that emerged from this situation include harm on marine ecosystems and habitats because their carrying capacities were exceeded. Socio-economic impacts comprised adverse effects on First Nations and their traditional cultural patterns and other marine resource users. Nowadays, this situation complicates the coordination of the industry with local and regional Land Use Plans (LUPs) and Coastal Zone Management Plans (CZMPs).

A final disadvantage is the exclusion of potentially suitable sites outside a selected region. Selecting a region of interest is usually the first step in choosing a site for facilities. It is therefore possible to exclude potential sites that may offer better environmental or socio-economic conditions but which nonetheless may be located outside selected regions. This case is typical for salmon aquaculture in BC as the industry concentrates to a large extent in two specific blocks, which together comprise over 50% of the total salmon net cage tenures in the province (Fig. 5).

4.3. Trade-offs of siting policy

Trade-offs refer to the need to balance objectives when they cannot be attained all at once. They indicate ways to express one objective in terms of another and ultimately depend on the consequences associated with initial objectives. Trade-offs can be cognitively difficult in that they require comparison between a wide array of dimensions and qualities.

In this case, an important trade-off is that larger buffers leave less area available for salmon farming, but mean greater environmental and social safety. The main trade-off that



Fig. 5 – British Columbia fish farm tenures in the Vancouver Island Region (Living Oceans Society, 2005).

arises from the use of siting criteria is that larger buffers leave less area available for the salmon aquaculture industry (given the type of existing technology). Buffers act as a constraint on the overall scale and economic potential of the industry, and limit its expansion. A limited number of sites can be projected in each region so economic benefits are constrained to that defined scale.

At the same time, however, larger buffers would mean more safety. Adverse environmental and social impacts are, in principle, decreased with larger buffers. Impacts on marine ecosystems and habitats are obviously decreased because there would be less area for salmon farming. Social impacts on traditional cultural patterns (i.e., their resource uses and diverse work activities), other marine uses (recreation and navigation) and aesthetics (noise, visual impacts and odours) are similarly decreased. In summary, larger buffers constrain economic potential but lessen environmental and social impacts.

4.4. Discussion

Policy evolution factors have played different roles during different periods of regulatory action. The agenda setting mechanism and its associated factors (focusing events, indicators and feedback) influenced the origin and initial evolution of siting policy at a time when social and environmental impacts needed urgent attention. Scientific evidence played an active role in determining optimal biophysical suitability for fish grow-out purposes, while feedback brought about policy that aimed at mediating resource user conflicts. Finally, the incrementalism mechanism itself, via expansion

and adjustment, played a role in shaping newer policy that largely evolved from initial regulations.

Typical siting criteria are constituted by *buffers* (i.e., proximity or separation distances) and *attributes* (i.e., environmental or socio-economic settings delimited by buffers themselves). Implicit disadvantages and trade-offs among conflicting objectives emerge during siting processes that use site-specific criteria. In addition, despite the fact that regulating agencies make use of the same *buffers* and *attributes*, the implementation of siting criteria remains subjective. Criteria may be either looked upon as guidelines (recommendations) or as stringent standards developed via precautionary common sense. *Buffers* are largely determined on a risk management basis given the lack of definitive science that supports them (Fisheries and Oceans Canada, 1998). Hence they are imposed in order to manage risks by providing a measure of protection. However, in the end, establishing criteria in the absence of scientific data has led to conflicts and controversy between stakeholders and policy makers.

5. Building knowledge toward the adoption of a precautionary approach

This section outlines three potential processes associated with facility siting that could benefit the generation of more precautionary policy. The first process yields siting decisions using public negotiation based on a procedure developed to site nuclear power plants and hazardous waste facilities in the United States (Kunreuther et al., 1993). The second process

takes an analytical perspective on siting by making use of a decision-making tool that aims to find 'best' sites while following a sound siting process. This method has been used by the energy sector in the U.S. (Keeney, 1980). Finally, the third process introduces a perspective where sites are regarded as components that co-exist within more broader and complex systems and are subject to cumulative effects, emergent properties and dynamic interactions. This process also places emphasis on the need to pursue regional planning.

5.1. Siting as a public process of negotiation

The nature of facility siting typically involves different stakeholders and their associated values, interests, preferences and proposed outcomes. Lack of trust and disagreement about values and goals may sometimes be seen as a major obstacle from a public perspective. These facts unquestionably generate conflicts and disputes. Consequently, negotiation tools and procedures become important to overcome disputes and to search for mutual gains. The Facility Siting Credo (FSC), a procedure developed for siting purposes per se, has proven beneficial in addressing stakeholder conflicts (Kunreuther et al., 1993). While it is not intended to be the unique solution for dealing with siting matters, the appropriate combination and implementation of siting negotiation procedures and techniques could possibly help assist the marine-based facility siting process from a stakeholder negotiation perspective.⁶

The FSC assists facility-siting negotiation and addresses the main sources of conflict. It involves six procedural steps: instituting a broad-based participatory process, seeking consensus, working to develop trust, seeking acceptable sites through volunteer processes, setting realistic timetables, and keeping options open at all times. There are also seven desired outcome stages: achieving agreement that the status quo is unacceptable, choosing the solution that best addresses the problem, guaranteeing stringent safety standards will be met, fully addressing all negative aspects of the facility, making the host community better off, using contingent agreements, and working for geographic fairness.

Accounting for public values in the siting process is expected to lead to improved decisions. Evidence has shown that both public participation and the building of trust between developers and host communities help deal with conflicting values, objectives, interests and preferences associated with stakeholders and decision makers (Kunreuther et al., 1993). From a public negotiation perspective, siting processes associated with marine-based aquaculture facilities may benefit from tools such as the FSC given that its participatory and active nature is likely to build trust and deliver enhanced results in the long run.

The core social factors of a fair and workable public negotiation process aimed at siting any type of (controversial)

⁶ Historically, the lack of rational, impartial and workable siting procedures has commonly generated conflicts between stakeholders, decision makers and facility proponents. Research then identified that trust between developers and host communities, public perceptions of appropriate facility design, and public participation were crucial for sound siting negotiation processes and long-term positive outcomes (Kunreuther et al., 1993).



Fig. 6 – Siting decision analysis (Keeney, 1980).

facility should include public participation, positive public perception and development of trust. Both process and outcome considerations are key ingredients for long-term success, since siting decisions do not only affect the final location and surrounding of a facility but also its future management.

5.2. Siting as an analytical process

The need for structured decision-making in siting requires strategies to find 'best' sites. As in other types of controversial facilities, the salmon aquaculture siting process is characterized by substantial structural complexity. Stakeholders and policy makers must address multiple objectives, alternatives, trade-offs, risks and uncertainties, among other factors. Siting process objectives therefore become crucial to guide decision-making. In this sense, strategies such as decision analysis (DA) provide an analytical framework to structure the complexity of the siting problem, while taking into consideration both stakeholder values and technical and scientific information (Keeney, 1980).

As far as the siting problem concerned, DA is a convenient risk management approach because it aids to develop solid siting processes using more comprehensive siting criteria. When applied to siting, decision-making begins with careful identification of candidate sites. General objectives and their performance measures (PMs) are then put forward, followed by detecting, describing and quantifying possible impacts associated with identified sites. Finally, the analysis evaluates such impacts and compares sites to select the most suitable one in terms of stakeholder values and best available information (Fig. 6).

In practical terms, the siting DA process first selects a region of interest by narrowing down the location to a specific area. This identifies numerous potential sites. Screening criteria are carefully set and applied under DA screening models, which state and quantify value judgements and indicate the level of attainment of the fundamental siting objectives. This step is intended to result in a series of candidate areas that are homogeneous. Appropriate candidate sites are identified by incorporating diverse opinions from several experts in different fields (e.g. oceanographers, demographers, geologists, economists, and so forth). Screening models are also applied at the local level. Professional judgements become easier at this stage given the resulting homogeneity of candidate areas.

Siting DA formally specifies objectives and PMs to gauge the degree to which objectives are being attained. The facility siting social and environmental dimensions discussed in Section 3 could provide an overall framework for establishing

objectives. PMs are ascribed to more specific objectives (i.e., sub-objectives or means objectives), which in combination indicate the levels of attainment of fundamental objectives. The impacts associated with every alternative are then identified and described based on their consequences and probabilities of occurrence. Formal models can be developed and applied to assess consequences and probabilities. The desirability of each possible consequence is quantified to evaluate the previously described impacts. Value trade-offs, equity and risk attitudes are addressed, while value judgements are made explicit. Values are elicited and clarified in order to assess the alternatives.

Up to this stage, the siting problem is considerably structured while the magnitude of its associated impacts has been explicitly determined. The suitability of DA assumptions can be verified at this point. The site selection process is determined via expected utility. All the gathered information is integrated to evaluate alternatives. Sensitivity analysis is then conducted with respect to preferences and impact inputs, to determine the sensitivity of decisions regarding uncertainties associated about the levels of impact. Finally, impacts are quantified, uncertainties are determined and the value structure is explicitly developed.

As a risk management problem, salmon aquaculture involves technical aspects comprised by exposure and effects, and social aspects comprised by risk perception and communication. To responsibly understand salmon aquaculture as a risk problem and to develop sensible criteria, its social context needs better understanding, especially in terms of the disconnection between public values and siting policy. Values are believed to be crucial to determine siting criteria. A characteristic feature of this type of the siting DA framework is that subjective judgements are incorporated into the analysis. In that sense, emphasis is placed on understanding central values and objectives. DA could provide a functional tool for the salmon aquaculture facility siting context because its features are innate to complex decision problems, i.e., multiple objectives, difficult identification of good alternatives, intangibles, long-term horizons, risk and uncertainty, impacted groups, interdisciplinary nature, as well as several decision makers, value trade-offs and risk perceptions (Keeney, 1982). In conclusion, siting DA aims at finding best available sites via a logically sound, justifiable and pragmatic decision-making process.

5.3. Siting from a systems perspective

Industrial aquaculture at the global level clearly follows an economic model that, to a large extent, overlooks ecological science. Profit maximization is stressed in order to compete in global markets. In this sense, priority is given to the amount of fish that are grown and harvested rather than the way in which they are grown or their impact on larger biophysical, socio-economic or cultural–ethical systems in which grow-out sites are embedded and dependant upon (Fig. 7). This way, “... industrial aquaculture concentrates on technological and managerial enhancement, leaving critical system dynamics questions unexplored” (Bavington, 2000). In Canada, this approach is illustrated by DFO’s Aquaculture Development Strategy,

which focuses on economic competitiveness “to gain stature in world aquaculture...” (Fisheries and Oceans Canada, 1995). This approach can easily overlook local and regional-level structures and disregard adverse impacts and consequences on other systems on which the industry depends.

Furthermore, as it happens with several other production-based industries, modern industrial aquaculture focuses on producing maximum output while minimizing capital input. The way in which such economic targets are accomplished tends to overlook the complex relationships that exist between the activities that occur in each site and the larger systems in which they are embedded. Similarly, risks and uncertainty (e.g., potential for unpredictable ecological changes and social conflict) are not sufficiently taken into consideration.

5.3.1. Sites as components of broader systems

Marine-based salmon aquaculture sites have dynamic interconnectedness with ecosystems (i.e., the biophysical system). Ecosystems are comprised by processes that bind organisms together and which influence ecosystem development, structure and function. The incorporation of salmon aquaculture sites into the structure of ecosystems has the potential to disrupt the natural, self-contained cycles, and the interaction and exchange of matter and energy within elements of ecosystems themselves. In addition, emergent properties introduce a great deal of uncertainty on both spatial and temporal scales. While ecosystems are dynamic, constantly changing and inherently complex, the typical managerial approaches of industrial aquaculture assume a world of simple rules. This results in siting criteria that considerably disregard ecological questions full of uncertainty (i.e., genetic effects and disease transfer, wild fish migration patterns, wastes and water quality, deleterious effects on marine mammals, cumulative impacts and so forth), and the overall ecological footprint of each site on a variety of faraway ecological and social systems.

Fish farms are also immersed within socio-economic and political structures. First, ‘intangibles’ such as the social identity of individuals and groups (e.g., fishers, local communities and First Nations groups) at the local level are

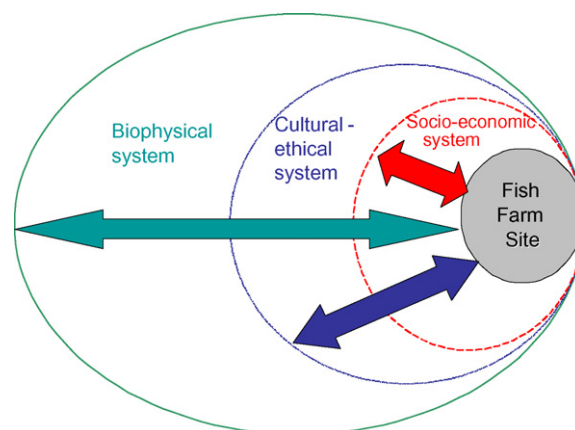


Fig. 7 – Fish farms as elements embedded within broader systems (adapted from Bavington, 2000).

threatened. Significant conflicts in coastal areas emerge (e.g., navigational safety issues, access to traditional fishing grounds, aesthetic concerns, impaired access to coastlines, and so forth) and externalities (social and ecological risks and costs) are also increased as aquaculture practices are privatized and economic profits are almost entirely attained by transnational corporations. These cumulative shifts of larger socio-economic structures should be regarded in the development of future siting policy.

Finally, modern salmon aquaculture is ultimately governed by a set of assumptions and intellectual models that constitute a complex cultural–ethical system. Its structure is “...mainly comprised by neoclassical economics (based on growth and industrialization), social democracy (based on individualism), anthropocentric ethics (based on utilitarianism) and a scientific paradigm geared toward reductionism” (Bavington, 2000). All these complex and multifaceted structures and their related functions are themselves components within a vast array of values and cultures that are significantly ignored in the development of siting criteria.

In light of the multiple dynamics between systems, salmon aquaculture siting policy in BC could consider the interrelatedness of the systems’ structures and functions. To look at salmon aquaculture from a systems perspective requires a new vision for managing sites and their operations. On this view, siting policy would need to consider uncertainties and therefore be re-structured.

5.3.2. Need for regional planning

The salmon aquaculture industry in BC is regulated by provincial and federal entities that have historically created a complex regulatory framework that focuses on a site-by-site approach. As such, current siting criteria have been specifically designed to select sites that, based on expert judgements, minimize environmental and social impacts (while having the appropriate biophysical set of conditions to carry out operations safely). This approach fails to consider cumulative impacts of fish farms on other systems (i.e., environmental and socio-economic) and does not support sound and sustainable regional planning (McDaniels et al., 2005).

There is a considerable degree of uncertainty with respect to the cumulative impacts that salmon farms have on both the biophysical environment (e.g., wild salmon stocks, other marine species, benthos, and so forth) and human health. Also, cumulative impacts with respect to economic development and social well being at various scales are uncertain. The application of siting criteria merely focuses on the local perspective, leaving the regional perspective nearly unconsidered. Regional effects are not regarded because each site is viewed as an individual and isolated system that needs to be ‘protected’ from the hazards imposed by other external systems.

A regional regulatory approach wherein site-by-site regulations are only considered in special cases is important if regional objectives are to be met. Regional objectives could consider cumulative impacts and other uncertainties. While a regional regulatory scheme may be complex to define, a systems perspective in combination with public negotiation and analytical (decision-making) processes, may importantly contribute to its various phases of development.

5.4. Discussion

These three processes are, in essence, suggestions for methods that could aid in guiding future siting processes concerning salmon aquaculture facilities. A formal salmon aquaculture facility siting process where multiple stakeholders and policy makers determine applicable siting criteria has not yet been designed in BC. So far, federal and provincial government policy makers have developed criteria on a mostly reactive basis. Siting criteria tend to perform only as standards since they only try to avoid further environmental damage and resource user conflicts. A strategic siting process based on participatory forms of stakeholder involvement, analytical procedures and regional planning under a systems perspective could contribute in creating more comprehensive siting policy. Future criteria may need to regard stakeholder values, scientific evidence and expert judgements under a regional approach while pursuing the fundamental objectives ultimately sought by the sector.

6. Conclusions

The experience with the evolution of regulatory processes for salmon aquaculture in British Columbia was used to illustrate how policy for a new industry originate and evolve over time. We have shown that both the origin and evolution of policy has, for the most part, been reactive and ultimately determined by factors associated with two policy analysis mechanisms: agenda setting and incrementalism. Based on our conceptual framework, focusing events, indicators and feedback usually emerge from scenarios that are characterized by complex dynamics between social, environmental and political issues, such as those in which new industries are inserted. The interaction of these factors tends to generate reactive policy outcomes (e.g., guidelines or criteria) instead of precautionary measures to regulate siting policy. This process is exemplified by the expansion, adjustment or replacement of existing policy. In addition, factors such as incrementalism, scientific evidence, following other jurisdictions’ leads and borrowing existent policy, tend to act independently and influence the evolution of policy via reaction as well.

Furthermore, our study showed that there are implicit disadvantages and trade-offs associated with reactive policy. In this case, disadvantages refer to inconveniences, conflicts or costs that could arise from the constitution and use of siting policy (i.e., siting criteria). A first disadvantage associated with current site selection processes is the exclusion of potentially suitable sites within and outside selected regions for aquaculture development (given the use of buffers and attributes in siting criteria). A second disadvantage is that siting policy disregards biophysical and socio-economic cumulative impacts, which hinder the integration of salmon aquaculture with region-smart plans. Another important disadvantage is the multiplication of adverse social and environmental impacts within a selected region for aquaculture development. Moreover, implicit trade-offs also arise from the adoption of reactive policy. An important one is that larger buffers leave less area available for salmon farming, but mean greater environmental and social safety.

Given the complexity embedded in the management of the salmon aquaculture industry in BC and the way the industry has evolved thus far, siting policy is likely to continue developing reactively via the mechanisms and factors that are explained in this study. To build knowledge toward the adoption of a more precautionary approach (one that attempts to balance environmental, socio-economic and governance goals), the industry could probably benefit from public processes of negotiation and analytical decision-making. Integrated, democratic and fair decision-making processes that consider stakeholder values, scientific evidence, expert judgments and a regional planning approach, are key elements that could benefit the future evolution of salmon aquaculture siting policy.

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