# ADAPTIVE RATIONALITY: GOVERNMENT POLICY TOWARDS ECOLOGICAL EFFECTS OF SALMON FARMING IN BRITISH COLUMBIA

by

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### ABSTRACT

The rapid 1980's development of the salmon farming industry in British Columbia has been called "a poorly defined experiment in a poorly understood coastal environment", and the main impetus behind it described as "the chaotic, bottom-line orientation" not only of the industry itself but also of relevant government policy. The purpose of this thesis is to elaborate on these themes by identifying and delineating the most significant reasoning models underlying government development policy; and to offer an evaluation of the policy's 'rationality'.

Throughout the development of the industry, but particularly in the early stages, two major areas of uncertainty have been prevalent. First, detailed government policy towards salmon farming has been far from clear - an inarticulation that is characteristic of the philosophy of laissez faire, which was particularly influential in Canadian government policy in the early 1980's. Secondly, a variety of possible ecological impacts have been suspected from the outset.

A heuristic approach, both for the basic method employed in the thesis and for the normative model set up to evaluate government policy, is advanced for addressing these different uncertainties. In order to identify relevant policy, it is hypothesized that systems of ideas expressed formally in 'core' models of neoconservative and neoclassical economics were particularly important policy influences.

It is argued that the core concept of neoconservative theory (as defined) is the adaptive efficiency of the autonomous market. The theory's fundamental adaptive ideas - economic information 'discovery' by competitive trial-and-error selection, and consumer

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'regulation' via the price system - are to be found in representative federal and provincial economic policy documents from the early 1980's, as well as in the occasional government elucidations of B.C. salmon farming policy (scattered in heterogeneous historical sources). An examination of (inferred) specific decisions relevant to ecological aspects of salmon farming reveals the influence of trial-and-error - deliberate omission of government planning - on early salmon farm siting policy; and the influence of the presumption of consumer 'sovereignty', which was assumed to obviate the need for government ecological regulation.

The relevant core concept of neoclassical economics (as defined) is the rational model derived from the conception of *homo economicus*. The model and its derivations are visible in the same early 1980's economic policy documents, which outline public sector 'restraint' criteria, as well as in salmon farming policy elucidations. It is argued that the maximizing 'solution' prescribed by the model is without operational significance in complex, uncertain situations, where ostensible use of the formal technique may be to legitimate decisions taken on other grounds.

The normative model set up to evaluate government policy is drawn from three sources: Friedrich Hayek's rationalization of the adaptive market process, C.S. Holling's prescriptions for "adaptive environmental assessment and management", and Herbert Simon's development of "procedural rationality". These models support the conclusion that acquisition of information by the agency that mediates actions and goals - which, in the case of ecological regulation, must be government - has major value as the basis of more rational decisions. But acquiring conclusive evidence by trial-and-error learning involves risk of serious error, particularly irreversible ecological harm, and it is rational to utilize the

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inconclusive evidence that is always available for making general predictions, in order to guide search and select lesser risks.

Incorporating the important constraint of search costs - particularly significant in the economic recession of the early 1980's - the requirements for rational adaptation become minimal, procedural ones of 'reasonableness': lack of bias towards any class of information relevant to social welfare; lack of denial of uncertainties, and thus of development risks, in the complex and little-known salmon farming environment; and timely response to uncertainties subsequently, adequately resolved by experience. It is suggested that all three requirements were infringed by government policy towards salmon farming development.

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#### CHAPTER ONE

### INTRODUCTION

### Purpose

The rapid 1980's development of the salmon farming industry in British Columbia has been described by its detractors as "a poorly defined experiment in a poorly understood coastal environment", the disordered product of the "chaotic, bottom-line orientation" of both industry and government policy. Not only has that policy been far from clear, but the industry's evolution has been accompanied throughout by the political rhetoric of both 'sides' [1], and in fact almost the only aspect of salmon farming that is beyond contesting is the confusion that surrounds the issue: *has* salmon farming had significant ecological effects?; *what* has government policy been, generally towards salmon farming development, and specifically towards any such ecological effects? The first objective of this thesis is to discover some order amidst the seeming chaos. On the basis of this increased understanding, the intention is then to offer an evaluation of government policy on salmon farming - specifically towards its ecological aspects - that is less partial than has perhaps been typical.

### Problem statement

It is appropriate here to introduce two fundamental assumptions, which, though virtual truisms, are nonetheless decisive for the particular direction that the analysis will take. They consist of an emphasis, in the field of human decision-making and reasoned action, on the significance of *change*, and on the limited scope of human cognition - in other

words, a conviction of the importance of *uncertainty*, which results from both. Prior to the rapid growth of B.C. salmon farming in the mid-1980's, the industry represented an opportunity for a novel type of development in the relatively undeveloped and little-known environment of the province's coastal inlets. Development, of course, meant change, which would compound the existing uncertainties of the situation. Government policy, and any planning of the industry's development, must be addressed primarily to this problem of heightened ignorance of present and future conditions: an appropriate stance would be an *adaptive* one [2], both aimed at reducing uncertainty and at responding effectively to new information and to the inevitable occurrence of the unexpected. The problem on which I shall focus involves the question - given the now-accepted importance of 'the ecological factor' in salmon farming - of *what would have been an appropriate adaptive development policy in ecological terms*.

A key word here is "appropriate", which is partly intended to permit incorporation of the 'no free lunch' insight common to economics and ecology. Opponents of the industry, for example, have argued that government's social responsibilities towards salmon farming development have not been fulfilled in that there has been an undeniable lack of comprehensive planning and a paucity of environmental regulation and enforcement. This criticism is 'partial' to the extent that it ignores the costs of those actions; and such costs were particularly strong constraints during the formative period for salmon farming policy, as Canada and British Columbia struggled to emerge from recession in the early 1980's. Incorporating this major concern, the general problem can be phrased in this way: how should government policy for economic development be designed to minimize environmental damage during times of recession in market economies?

A subsidiary, though nonetheless significant problem, also relates to the issue of uncertainty. In hindsight, an important 'ecological factor' - primarily consisting of significant ecological risks - is now apparent. But few of these definitive risks were identified at the formative stage of salmon farming policy. How could government fulfill its responsibility to address ecological problems, if these were unknown at the time? The only possible resolution of this conundrum lies in an adaptive process, the focus of which must be the 'management' of information over time for the appropriate reduction of relevant uncertainty. Such a process would discover hitherto unknown information for identifying and addressing problems, in an appropriate way - cost-effectively and not irreversibly - learning, for example, by responsible and responsive trial-and-error and successive approximation [3].

# **Research questions**

The first largely descriptive - though not uncontroversial - task is to support the assertion made above, that some serious ecological problems can be attributed to B.C. salmon farming, and to find some commonalities between these problems that make them amenable to analysis. More fundamental in addressing the first purpose of the thesis - to try to find order, or achieve effective simplification, in the confusion - is the attempted identification of the most significant philosophical premises underlying government policy towards salmon farming. The early 1980's saw not only serious recession in Canada, but also a deliberately increased reliance on 'market forces' for addressing economic and even social problems. The argument behind this policy direction is based on adaptive economic efficiency: given continual change in the different constituents of the economic system,

competition and the price system discover, communicate and respond to diverse new information about supply and demand in an autonomous, self-regulating human system that is allocatively far more versatile and cost-effective than central planning. Where such planning *is* necessary, as in setting the conditions for industrial development and organizing the functions of government itself, other economics prescriptions, such as harnessing private incentives and improving productivity 'at the margin', can also be employed to improve efficiency, though this involves deliberate calculated foresight rather than reliance on the adaptive mechanism of the Invisible Hand.

There is ample evidence of the influence of both these rather different notions of efficiency - adaptive and calculated - on Canadian economic policy in the early 1980's, when squeezing as much as possible out of very limited resources was considered a particularly high priority. There is also evidence of the strong influence of these models - which for purposes of exposition I shall delineate as neoconservative and neoclassical economics ones - on policy towards salmon farming in British Columbia. Though of course government policy is the product of myriad influences, of which more are likely to be pragmatic than intellectual, it is my contention that basic academic economic ideas were integral to policy in this case [4]. It has been observed that while its specific conclusions may not often be heeded in real-life decision-making, academic economics *may* however contribute to policy <sup>m</sup>a basic orientation and general framework' or 'the simplest, most elementary concepts of economic theory<sup>m</sup> (Rhoads, 1985, p.3). These "basic" ideas are the philosophical underpinnings of the discipline. If these can be detailed and related effectively to government policy towards salmon farming, particularly its ecological aspects, then a form of simplification will have been achieved.

The central research aim is thus to describe the relevant 'philosophical', or underlying, aspects of the two descriptive/prescriptive models, and relate them to government policy towards salmon farming. The purpose here is at least partly heuristic. I am assuming that there is some reason, or rationality, behind the policy, and that the cause of its obscurity lies in the complexity of influences on that policy, rather than in its completely chaotic nature. As political scientist Herbert Simon, whose work I shall draw on extensively, writes of the theory of heuristic search, it is

... concerned with devising or identifying search procedures that will permit systems of limited computational capacity to make complex decisions and solve difficult problems.... When a task environment has patterned structure, so that solutions to a search problem are not scattered randomly throughout it, but are located in ways related to the structure, then an intelligent system capable of detecting the pattern can exploit it in order to search for solutions in a highly selective way (1978b, p.12).

Given that there *is* some rationality behind this policy, and that government policy is the product of multiple, complex influences, it seems reasonable to fix on the relatively coherent neoconservative and neoclassical models as vehicles of explanation and thus understanding, since the pattern of their influence is readily discernible. After all, only on the basis of understanding - however incomplete - can a rational *evaluation* be made.

That these models had an important influence on salmon farming policy can be used in a sense as a working hypothesis. The models initially provide an approximation of an actual pattern in government policy; their theoretical coherence then allows them to be analysed relatively simply; and this analysis can be applied, with suitable modifications, to real policy statements and actions. In other words, if these models do not comprise a structure that analysis reveals is 'appropriately adaptive' in ecological terms, *it is not likely* that policies based (at least in part) on them will do so. Having set up normative criteria for

'appropriate ecological adaptiveness', the question of whether salmon farming policy actually fulfilled them is an empirical matter, but it should be considerably simplified and clarified by the prior analysis.

Several research questions, or directions, follow from all this. To begin with, summarizing the general economic policy background will be useful in establishing a 'reservoir' of clear policy statements and ideas from which to draw. Next - if I intend to analyse the two academic models as an expedient for understanding actual policy - I need to provide strong grounds *before* this analysis for believing that the hypothesis (that the models had an important influence on salmon farming policy) is adequate. This can be done by initially identifying distinctive features of the models in any salmon farming policy statements. Having established the likelihood of the influence of the two theories on salmon farming policy, a theoretical analysis of their 'ecological adaptiveness' can be made. This can be applied to the general economic policy context discussed previously, in order to discern how the theories have been interpreted in practice and under the constraints of pragmatism [5]. What is then required is an attempt to relate the models' basic features to actual salmon farming policy which had ecological repercussions; and lastly, an analysis of the ecological adaptiveness of policy acts and omissions, particularly those identified as having been influenced by neoconservative and neoclassical ideas.

### Criteria of judgment

"Uncertainty" is a particularly vague term, and the fact that it has been ascribed a fairly limited scope and specific meaning in some sciences is highly indicative of the general perspective underlying those disciplines. In ecology, on the other hand, uncertainty, both empirically and theoretically, is pervasive, multi-faceted, and fundamentally significant. This partly reflects a different philosophical orientation from the more reductionist sciences, such as physics. As Holling and his colleagues put it, in categorizing the numerous intellectual problems in environmental (ecological) assessment and planning, "all of these unresolved issues relate in one way or another to the theme of *uncertainty*. We believe these issues to be philosophically important; our view of the world is inseparable from our view of uncertainty. We also believe these issues to be pragmatically important... because uncertainty is real...." (1978, p.132). The experience of real-world uncertainty that colours the ecological "view" is based on the obvious, observable complexity of ecological systems: "Ecological relationships are seldom unidirectional, linear, or simple. Causal linkages are often reciprocal, indirect, circular, probabilistic, contingent, delayed, multiplicative, interactive and synergistic" (Bartlett, 1986, p.230).

Of the concepts underlying these adjectives, *contingency* is perhaps the most philosophically significant. A contingent result is one that depends on some future uncertain event: it is therefore, even in theory, quite unpredictable, or indeterminate. 'Surprises' of this kind are commonplace in reality:

Often the most significant factors in determining the future are the irrationals. By "irrational" I do not mean subjective or neurotic, because from the standpoint of science any small quantity or unique occasion may be considered as an irrational, since it does not lend itself to statistical treatment and repeated observation. Under this head, we must allow, when we consider the future, for the possibility of miracles.... By a miracle, we mean not something outside the order of nature but something occurring so infrequently and bringing about such a radical change that one cannot include it in any statistical prediction (Mumford, 1956).

This view - that there *are* such things as contingencies and irrationals - is the philosophy of indeterminism, the belief that unique conjunctures, though scientifically

almost invisible [6], really do exist or take place. Determinism, by contrast, is the equally undemonstrable belief that every event has a cause, and that nature is everywhere subject to natural laws - the traditional scientific view. For indeterminism, uncertainty (about the future) is axiomatic; for determinism, presumably, all uncertainty is ultimately resolvable.

These opposing views operate at a cognitive level prior to our everyday experience - at the level of deeply-held philosophical conviction - and profoundly affect our attitudes towards predictability, irrespective of the empirical evidence before us. Different planning prescriptions - prescriptions of how to make reasonable decisions about the future - are the result. Since, according to determinism, every event has a cause, then every future event, even the minutest, is (theoretically) predictable: all you need to know is the relevant scientific law (causal relationship) and the relevant factual conditions. Since every event can in theory be predicted - or could be, if we had the data - the emphasis is on attaining such perfect prediction. Thus Holling asserts that a persistent myth in environmental assessment is that it should aim "... to eliminate uncertainty regarding the consequences of proposed developments [ie. to make accurate advance predictions]" (1978, p.4). Equally, "the majority of environmental modeling efforts... apparently assum[e] high-guality predictions once all known relations between variables are included" (ibid., p.95). By contrast, he argues that "attempts to eliminate uncertainty are delusory and often counterproductive. The appropriate concept for both assessment and policy design is a recognition of the inevitability of uncertainties and the consequent selective risk-taking" (p.5). In other words, "... the fundamental challenge is not simply to better mobilize known information. Rather, it is to cope with the uncertain and the unexpected. How, in short, to

plan in the face of the unknown" (p.7). What is required in environmental planning is "... a new perspective - a perspective that recognizes adaptability and responsiveness rather than prediction and tight control, and a perspective that actively views uncertainty as a fundamental facet of environmental life rather than as a distasteful transition to attainable certainty" (p.139).

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This indeterminist perspective is a much closer approximation, I would suggest, to observable ecological fact than its antithesis. In the real world of natural and human life, "... however intensively and extensively data are collected, however much we know of how the system functions, the domain of our knowledge of specific ecological and social systems is small when compared to that of our ignorance" (Holling, 1978, p.7). Not only are ecological systems characterized by "... a permanent and inherent state of change..." (p.19), but often, also, "events at one place can re-emerge as impacts at distant places", and "impacts are not necessarily immediate and gradual; they can appear abruptly some time after the event" (p.20). Only at the level of inert matter and in relatively simple, man-made systems - such as machines and models - which are bounded and largely closed, can perfect, non-trivial predictions of system behaviour be made. Not by accident is the philosophy of determinism based on a mechanical metaphor - the wholly predictable, 'clockwork' Newtonian universe. This model may be an appropriate heuristic for the study of mechanics, but for the everyday complexity of human planning it is not. As Herbert Simon puts it:

For most problems that Man encounters in the real world, no procedure that he can carry out with his information processing equipment will enable him to discover the optimal solution [which depends on infallible deductive prediction].... There is no logical reason why this need be so; it is simply a rather obvious empirical fact about the world we live in - a fact about the relation between the enormous complexity of

that world and the modest information-processing capabilities with which Man is endowed (1976, p.135).

Thus, in real-life planning situations - even those that are relatively well-bounded, such as project environmental assessments, and where the relevant data are excellent accurate, comprehensive prediction is not in practice achievable, and is not a sensible objective. "Attempting to close the gap on imperfect predictions detracts from a proper focus on the consequences of the inherent uncertainties that will always remain. If prophecy is impossible, then go for understanding" (Holling, 1978, p.133).

Ignorance of present and future conditions could not have been more 'real' than in the present case. B.C. salmon farming in the early 1980's presented a veritable catalogue of uncertainties. Data were poor or nonexistent, the geographical extent large and diverse; unprecedented man-made introductions were to be made to this environment, with the industry due to evolve (change) rapidly. In these circumstances, policy addressed to the industry as a whole would have to concern itself, willy-nilly, primarily with responding to events and information as they arose or came to light. What, then, would have been an appropriate policy?

Disregarding the fact that the policy was inevitably adaptive - changing, in detail at least, in response to a variety of pressures and discoveries - we *could* judge 'appropriateness' by a form of hindsight accounting. This would be as theoretically simple and pragmatically impossible as adding up all costs and benefits of the policy in terms of some consistent measure (or at least making a reasoned approximation of them) and comparing the two. This is not practicable because of the diversity and incommensurability of possible costs and benefits, the difficulty of attributing their cause to government policy, the continued change and lack of articulation of that policy, the uncertainty that still

surrounds the possibility of, for example, ecological costs, and the probability that all the consequences of any policy have not yet occurred.

Any such 'account' is also to an extent inappropriate, if the policy evaluation is to be in any sense prescriptive, or constructive, rather than merely vindictive. It is worth at this point taking a small excursion into cost-benefit analysis (CBA). This method of analysis (for evaluation and prescription) of potential state actions originated in economics, specifically welfare economics (Brooks, 1989, p.68). Accordingly, it is based on the rationalist assumptions of neoclassical economics, which I shall describe in more detail below. The rational model of policy analysis involves identification of the problem to be addressed, clarification of objectives, "identification of all possible means/policies for achieving [these] goals and objectives, consideration [ie. prediction] of the consequences following from each alternative policy identified..., comparison of the consequences... and selection of the policy that maximizes the goals... at least cost" (ibid., p.66). As a variant of this model, CBA involves comparing the predicted consequences of alternative state actions, and choosing the alternative that will maximize social welfare. It thus consists of a one-time, pre-action prediction, confidence in the reliability and comprehensiveness of which is presumably an adequate basis for government decision and action. Arguably, only in very simple, well-known and well-understood situations is such confidence justified. For example, accurate long-term prediction even of many inanimate processes, described by well-verified causal relationships, is impossible in their real-world context of complex systems:

First, we can never know the present completely; second, we are not able to make errorless deductions from what we know; and third, our limited imaginations may prevent us from asking the right questions. Depending on the complexity of the system

with which we are concerned, we always arrive - sooner or later - at a cutoff point beyond which reliance on scientific analysis [for precise predictions] becomes superstition because it can tell us no more than intuition or reliance on chance... (Kraus, 1974).

Thus, in more complex systems, such as biological and human ones, our ability to predict is

particularly limited:

One cannot predict the exact position of a ball after two or three rebounds from the walls of a squash court. The initial movement of the ball is never known precisely. This uncertainty may be small, but it is amplified at each bounce. [A hurricane] could have been set going by the wingbeat of a solitary gull somewhere over the wide ocean.... All science involves simplifications. There is an inevitable discrepancy between

our scientific models [the main source of precise predictions] and the much more richly textured world of everyday experience.... This means that the model does not contain all the information which would be needed to simulate a process as it really occurs. The resulting uncertainty grows with time....

In general, uncertainty increases with the number of possible answers to a question.... One can get a good prediction only in answer to a relatively crude question. There is always a trade-off between information content and reliability (ibid.).

So the usefulness of predictions about real world systems declines with decreasing information and understanding of the system, increasing complexity (which, amongst other things, compounds errors of calculation), and increasing time-scale (which increases the possibility of non-linear change). The B.C. salmon farming situation displays fairly extreme values of all these factors. An advance CBA would have been quite inappropriate, since to predict all significant costs and benefits would have required excellent information, understanding and some simplicity, none of which were present. A *hindsight* CBA would therefore also be misleading, since, even if all significant costs and benefits of salmon farming were now known, they could not have been accurately predicted and thus planned-for in advance, and could not be planned-for in advance in a comparable situation in the future. As a *prescriptive* device, hindsight CBA is therefore useless here.

It should not need saying, but prediction and control, which Holling disparages as objectives even for much simpler planning situations - favouring reasoned adaptation instead - are of course out of the question in this case; as Simon notes, "the rationality of planning and development models [is] predominantly a procedural rationality [a measure of the appropriateness of the planning model, or procedure, for discovering adaptive behaviour]" (1976, p.138). (The notion of prediction and control in planning, though seemingly far-fetched in the relatively chaotic circumstances of B.C. salmon farming, is not entirely a straw man, as I shall explain below.)

Given the need for adaptive planning in the circumstances of this case (indeed in any such economic development scenario), and the inappropriateness of what I have called 'hindsight accounting' for evaluating government policy, an alternative evaluative model can be compiled from three main sources (each of which I have already mentioned). All three share a conviction that in economic planning - the rational allocation of scarce 'resources', including ecological assets, over time - determinism, or at least the emphasis that derives from it on man's ability to predict and control significant aspects of the future, is an inappropriate philosophy. Each of these theories is based on the empirically well-founded view that the predictions that can actually be made about the complex, interrelated systems of human and biological interactions are profoundly limited.

The first source is the (neoconservative) model of the so-called market mechanism itself. The main economic justification of the market system provided by this theory surrounds the concept of information - the raw material of planning, and obviously central to the *rational* use of resources. The most coherent modern formulator of the theory, Friedrich Hayek, puts it in terms of efficiency:

We are only beginning to understand on how subtle a communication system the functioning of an advanced industrial society is based - a communications system which we call the market and which turns out to be a more efficient mechanism for digesting dispersed information than any that man has deliberately designed (quoted in Nishiyama & Leube, 1984, p.276).

According to Hayek, "... the economic problem of society is mainly one of rapid adaptation to changes in the particular circumstances of time and place..." (ibid., p.217). The most important factors affecting the rational allocation of resources are constant change in economic conditions (such as supply and demand), and the fact that most important economic information is dispersed among individual producers and consumers, who alone know the 'particular circumstances' of their own time and place, their own plans, and needs and wants - which it is the object of the economic system to fulfil. The problem for the economic system - for a society wishing to benefit from co-ordinated economic activity - is how to acquire and communicate this dispersed, constantly-changing information. We are faced with "the unavoidable imperfection of man's [individuals' and society's] knowledge and the consequent need for a process by which [economic] knowledge is constantly communicated and acquired" (p.223). In the market economy this is achieved by competition and the price system: competition 'discovers' new opportunities (resulting from changing supply and demand), while the price system gives individuals the opportunity to contribute their own unique knowledge, communicates this to other individuals by means of price 'signals', and thereby co-ordinates adjustments between consumer needs and wants, and resource availabilities. This is the model of the autonomous, self-regulating economy, which contrasts strongly with the stereotype of the centrally-planned alternative. In the latter, at its most extreme involving "direction of the whole economic system according to one unified plan" (p.213), only economic information that is generalizable can be utilized

by the central planning authority: it cannot know the 'particular facts' known only to individuals, or the contingencies of the future - sources of unique information ('irrationals') that cannot be discerned by generalizations, such as scientific 'laws', which are a source of precise predictions about the future. The centrally-planned economy incurs huge search and communication costs, in centrally amassing 'comprehensive' economic data and attempting deliberately to co-ordinate the entire economic system; is ineffective at finding out much of the most important information about present and future supply and demand; and is poorly responsive to change, since recalculation of the plan is obviously costly and difficult. In market economies, on the other hand, "the most significant fact about [the price] system is the economy of knowledge with which it operates, or how little the individual participants need to know in order to be able to take the right action" (p.219). 'The market' is characterized by selective - because decentralized - rather than comprehensive search; automatic co-ordination; adaptive feedback; and a more effective fulfilment of individuals' needs and wants, it would seem, than its socialist rival. Greater efficiencies, it seems, stem from lower information and attention costs, and the greater responsiveness of the system.

This model, gross oversimplification of the market system though it obviously is, has perhaps been vindicated to an extent by the recent collapse of many centrally-planned economies. It is certainly worth extracting those of its features that are apparently conducive to an efficient 'management' of information for resource planning, towards an evaluative and prescriptive model for this thesis. But the problem of the thesis involves the question of what would have been an appropriate adaptive policy in *ecological* terms, and the market mechanism - comprising price system and competition for profit - is largely

oblivious to information about biological systems whose value does not lie primarily in their components' becoming commodities. A *rational* planning scheme - in some sense the product of deliberate design - is required, one that provides substitutes for some of the desired features of the arational, autonomous market mechanism. An appropriate approach is suggested by the "adaptive environmental assessment and management" (AEAM) method of the Holling team.

This perspective is set up in opposition to the traditional, predictive models of environmental assessment and cost-benefit analysis, which assume "... that incremental approaches to planning and design, or marginal assumptions..., or smooth discounting functions are all appropriate techniques of ecological policy design and evaluation. None of those assumptions holds in a world that has more than one equilibrium or stability region, where sharp rather than gradual changes can occur" (Holling, 1978, p.33). The spatial heterogeneity and dynamic variability of ecological systems, the "... inherent nonlinearities, thresholds, time delays, and spatial redistributions" (ibid., p.137) that typify them, mean that comprehensive prediction is a wholly inadequate method for environmental planning, that much of the most important information about the behaviour of these systems is unpredictable, and that these uncertainties increase with physical and temporal scale and intensity of human interference.

The first step in policy design is thus to admit the significance of ineluctable uncertainty, not only about present conditions, or measurable data, but also about many cause-and-effect reactions within the functioning system. With the focus then on "... the consequences of inherent uncertainties that will always remain" rather than on "attempting to close the gap on imperfect predictions" (p.133), an adaptive procedure is required to

reduce uncertainty and somehow design for the occurrence of the unexpected. Each ecological system, and its behaviour - being characterized by heterogeneity and dynamism - is unique, so set techniques, or 'recipes' (such as mythical, mechanical 'optimization' (p.16)) are inappropriate for adaptive management. "We need to learn how to gain information as we proceed with management. We need to choose an adaptive analysis that utilizes a variety of techniques so that insight from one will help foster understanding of another. We need to learn how to avoid irreversible decisions at the beginning, when data are being acquired. Above all, we need creative methods for acknowledging uncertainty and progressing in the face of it" (p.80). Flexible, creative judgment - within general groundrules - is required to fit the procedure to the particular requirements of the situation.

Thus, although most *specific* impacts may be unpredictable, general *types* of impact are often anticipable (p.3). Having judged what types of effects are likely to be significant, a selective search can then be made for (what are judged) relevant data - "... the emphasis is put upon collecting only the relevant data, without following the traditional massive data collection procedure" (p.19). The efficiency implications here, in minimizing search costs, are obvious. Next, since prediction of only a minority of effects is possible, we need, for successful planning, to learn unknown, unpredictable effects - the majority - by observation of the system's behaviour over time; and "... the proper direction lies in the design of policies and economic developments that can allow *trial-and-error* to work again":

[Man's] customary method of dealing with the unknown has been trial-and-error. Existing information is used to set up a trial. Any errors provide additional information to modify subsequent efforts. Such "failures" create the experience and information upon which new information is built.... the modern scientist's development of hypotheses and experiments [is] in this tradition. The success of this time-honored method, however, depends on some minimum conditions. The experiment should not, ideally, destroy the experimenter - or at least someone must be left to learn from it. Nor should the experiment cause irreversible changes in the environment. The experimenter should be able to start again, having been humbled and enlightened by a "failure". And finally, the experimenter must be *willing* to start again (p.8).

Several principles are evident here. Decision-making in the face of the unknown inevitably involves risk; but such risk-taking can and should be *selective* (p.5) - again a judgmental characteristic, a good judgment being based on the best practicable information and on a reasonable degree of caution, corresponding to our admitted ignorance. Every opportunity should therefore be taken to incorporate into planning reliable new information - as it arises, whether it is deliberately obtained through experimental design, or the product of ad hoc experience. Monitoring should continue throughout development, further to reduce uncertainty and to record changes. Of course, appropriate response to the information of, and response to, new (changing) information resembles the cybernetic model, a mechanical form of which, for example, is the thermostat, which is designed to adapt costly output to changing conditions in order to approximate the desired outcome over time - minimizing costs and maximizing benefits, as far as possible, by means of a continuous process operating in a changing environment.

The AEAM approach is significantly different from the market model described above, in that the market's supposed trial-and-error procedure is blind, or arational, a blunt learning instrument unashamedly producing waste at the same time as unearthing unknown information, whereas Holling's method attempts rationally to minimize the possibility of major error, especially of irreversibilities. But there are major similarities in the prescriptions for (efficient) selective search and, particularly, for an (effective) adaptive process for acquiring uncertain information and using it to match decision-making and

action to social requirements or objectives. The continuous *procedure* common to both models is of paramount importance; even at the level of complexity of environmental planning, much lower than that of the economic system as a whole, the aim of AEAM "... is no longer prediction of what will happen or even what will most likely happen. Environmental assessment should be an *ongoing investigation into*, not a *one-time prediction of*, impacts" (p.133).

My third source of evaluative and prescriptive criteria, which follows a line of thought parallel to the analysis I have drawn out from the other two, is political scientist Herbert Simon's elucidation of "procedural rationality". This conception was formulated partly as a behaviourist reaction to the determinism of neoclassical economics. For that discipline, rational behaviour means choosing the correct (best or optimal) means to given ends. This "substantive rationality" thus refers to behaviour "... appropriate to the achievement of given goals within the limits imposed by given conditions and constraints.... the rationality of behavior depends upon the actor in only a single respect - his goals. Given these goals, the rational [ity of] behavior is determined entirely by the characteristics of the environment in which it takes place" (Simon, 1976, pp.130-31). Neoclassical economics assumes that the (economic) actor chooses optimally - in line with the objective solution to the means-ends problem - or at least that he should, and therefore can, do so. According to Simon, in many cases even the latter, weaker assumption is simply not true - an objectively correct decision cannot be made - for the following reasons. Any decision or choice entails consequences. A substantively rational choice - one that is the correct means to given ends - requires that the consequences of alternatives be calculable, so that these potential effects can be compared and the best alternative to meet the given ends chosen. In

situations of any complexity - most real-world situations - not only are many alternatives for choice unlikely to be envisaged, but their consequences are likely to be incalculable - or unpredictable, for the reasons given generally above for the limits to systems predictions. As Simon puts it, "the capacity of the human mind for formulating and solving complex problems [envisioning and calculating the best means to given ends] is very small compared with the size of the problems whose solution is required for objectively rational behavior in the real world - or even for a reasonable approximation to such objective rationality" (1957, p.198). Thus, contrary to the assumptions of neoclassical economics, "... choice is not determined uniquely by the objective characteristics of the problem situation, but depends also on the particular heuristic process that is used to reach the decision" (1979, p.507): since in many cases we cannot envision many alternatives nor accurately predict their consequences, it is rational, and normal, to try to enlarge our grasp of the possibilities and increase our knowledge of their possible effects - to search and learn (a "heuristic process"). Simon continues: "It would appear, therefore, that a model of process is an essential component in any positive theory of decision making that purports to describe the real world..." (ibid.).

He supplies such a model in his conception of procedural rationality, which "... describes an intelligent system's ability to discover appropriate adaptive behavior" (Bartlett, 1986, p.224), or "... the effectiveness, in light of human cognitive powers and limitations, of the procedures used to choose actions" (Simon, 1978b, p.9). We have here, once again, the underlying assumptions of the importance of limitations on human cognitive capacity (which is why substantive rationality, which presumes perfect knowledge, is usually an inappropriate standard for real-life decision making), and of the significance of

change: decision-makers live in "... a world with rapidly advancing human knowledge and technology, with an unpredictably shifting political situation, with recurrent and unforeseen (if not always unforeseeable) impacts of demographic, environmental, and other changes..." (1978a, p.505). In these circumstances of uncertainty, inherent in the mind and the environment of the decision-maker, the descriptive and prescriptive focus shifts from what decisions are made, to how they are made (ibid., p.494). A good decision appropriate to given ends - can be judged as such by its consequences, or outcome. But if there is no way of calculating these consequences in advance - because in a complex situation they may often be unpredictable - there is little point in prescribing the decision and action based on it. Thus in basic neoclassical economics, the prescription may be to 'set output at a level where marginal benefits will equal marginal costs', which is no doubt theoretically correct; but for the prescribed action to be taken, the deterministic, functional relationship between output and all costs and benefits must be known - so knowledge of all significant present conditions and accurate prediction is required. In complex, uncertain situations this requirement cannot be met, so the prescription is futile; and indeed the *more* complex and uncertain the situation, the more the decision-maker's focus should be on acquiring the necessary information (to reduce uncertainty) in order to *improve* the rationality of any decision, and on taking measures to reduce the impact of inevitable errors. The focus thus shifts to describing and prescribing how decisions are and should be made. The following are Simon's procedural prescriptions for businesses (whose goal, supposedly, is maximizing profits):

Once we become interested in the procedures - the rational processes - that economic actors use to cope with uncertainty, we must broaden our horizons further. Uncertainty not only calls forth forecasting procedures; it also calls forth a whole

range of actions to reduce uncertainty, or at least to make outcomes less dependent upon it. These actions are of at least four kinds: (i) intelligence actions to improve the data on which forecasts are based, to obtain new data, and to improve the forecasting models; (ii) actions to buffer the effects of forecast errors: holding inventories, insuring, and hedging, for example; (iii) actions to reduce the sensitivity of outcomes to the [mutually-related, thus unpredictable] behavior of competitors...; (iv) actions to enlarge the range of alternatives whenever the perceived alternatives involve high risk" (1976, pp.143-44).

There is a strong similarity between these prescriptions and Holling's design principles - because they have the same overall objective: adaptive effectiveness (the ability to meet goals effectively, if approximately, under conditions of change and uncertainty). The models share the requirement of flexible, even intuitive judgment, or "reasonableness", in these difficult circumstances - where it is more effective than inflexible, overly-precise and empirically-blinkered deductive calculation; thus "reasonable men' reach 'reasonable' conclusions in circumstances where they have no prospect of applying classical models of substantive rationality" (Simon, 1978b, p.14). In fact procedural rationality is a particularly appropriate general normative criterion to use in this thesis [7], because it does have a complex psychological basis - it "... refers to the cognitive processes and procedures used to choose actions" (Bartlett, 1986, p.224) - and the thesis is to use two, necessarily cognitive models (neoconservative and neoclassical economics ones) as a heuristic for understanding and evaluating government policy.

## Specific normative criteria

Drawing on these three sources, I am now in a position to define more closely what I meant earlier by an 'appropriate adaptive policy in ecological terms', and to set out some normative criteria by which to judge this. I shall extract common features from the three prescriptive source models, none of which is adequate on its own to provide the criteria for

policy towards ecological effects of salmon farming, since the first refers to different subject matter (consumption values), and the other two apply at less complex levels of analysis (more narrowly environmental and business planning). (All are relevant to an appropriate ecologically adaptive policy, though, as will become clear in the course of the thesis.)

All three models are based on the assumption that in complex and/or poorly-known situations, particularly in dynamic systems such as living ones, the scope of one-time prediction is limited and we must therefore turn to a continuing, learning process in order to derive the information necessary for rational future action. This involves the continual acquisition of new (ie. more accurate) information - deriving from the expansion of knowledge of existing conditions and relationships, and from perception of changes in conditions - and use of this new information to adapt decision-making accordingly as it is acquired. The procedure should therefore involve: *search*, to reduce uncertainty, providing new, better information on which better predictions and thus more rational decisions can be based, and to cope with continual change; '*insurance*' of some kind, to buffer the effect of inevitable errors of prediction; and '*feedback*', or response to the new, better information as it is acquired.

If rationality involves behaviour that is appropriate to the achievement of given goals (Simon, 1964, p.573), then, in the absence of knowledge of (anywhere near) all the parameters that determine what would be the best means to these ends, it is rational to acquire information that is relevant to, or leads in the direction of, achieving those goals [8]. Information, as Holling says, "... can be given a value just as jobs, income, and profit can" (1978, p.20); acquisition of information is valuable, because it is the basis of better

decision-making, or the better achievement of given goals. Thus Holling's 'selective search' involves the acquisition of information judged *relevant to the goal* of minimizing environmental impact. Equally, given that protection of the ecological resources risked by salmon farming is and has been an important social goal (see below for details), and given our obvious ignorance of how to achieve it (see Chapter Three), procedurally rational (appropriately adaptive) government policy, the concern of which is social welfare, would have included acquisition of information for ecological protection.

There is another way of reaching a similar, but stronger conclusion. Simon defines procedural rationality as "behavior [which]... is the outcome of appropriate deliberation. Its procedural rationality depends on the process that generated it" (1976, p.131). It does not refer to an attribute of an *action* selected by a choice process, but to an attribute of the choice *process* itself. We are looking for 'a style of behaviour that is appropriate to the achievement of given goals': so what would be an attribute of the reasoning process in government policy that is appropriate to the achievement of social welfare? One obvious feature is lack of bias: if rational decision-making and action (appropriate to given goals) depend on information relevant to those goals, then significant neglect of information relevant to any goal is irrational. Consistent, significant neglect may be evidence of systematic bias, which is procedurally irrational: if such bias against 'relevant' information - relevant to a social goal such as ecological protection - is evident in the reasoning behind government policy, such policy is likely to have been inadequately adaptive.

My second normative criterion for government policy also involves information, and how to act when it is 'imperfect'. As Holling says, "the appropriate concept for... policy

design is a recognition of the inevitability of uncertainties and the consequent selective risk-taking" (1978, p.5; italics added). Self-evidently, decisions whose outcomes are uncertain (unpredictable) often incur risks that the goals they were designed to serve will not be met or will actually be detracted from. Against the pervasive uncertainty of the present case, development was bound to incur risks: *some* risks were inevitable. Equally, given the fact of economic development, some risks were *necessary* : if learning about how best to satisfy social goals - including how better to satisfy economic ones - is largely a trial-and-error procedure, as the market model suggests, then the risk of error is a necessary precondition for such learning. But that is far from the end of the story. We can take measures to reduce risks and select out unacceptable ones. The first step is to admit uncertainty - to recognize that in complex and/or little-known situations, such as many ecological systems, few of the impacts of man-made changes may be precisely predictable. either, perhaps, in theory, or, certainly, in real-life practice. There may be a possibility, or risk, that some outcomes will be harmful. We should not neglect or deny these possibilities - otherwise we may suffer "[the] 'Titanic effect': when uncertainties are wished away and not planned for, the crises that follow are all the more intense" (Holling, 1978, p.134). Policy should not systematically neglect, or fail to reduce uncertainty about, information relevant to any important goal (which is the 'search' criterion already discussed), nor should it deny the risks stemming from decisions taken under uncertainty. Denial involves more active behaviour than mere neglect, implying the existence of some accurate information about the future (which to deny). Indeed, some general information about the future is nearly always available, even if few precise predictions are possible. Thus, environmental impact assessments are required in situations considered likely to

have significant ecological impacts, even though at the time this prior judgment is made few specific impacts, presumably, have been predicted (which is why the predictive EIA is required). So general, approximate information - such as that deriving from comparable but not wholly similar cases - can be used to anticipate (though not predict) a general class of impacts. These generalizations can be used to direct the search for more specific information in order to reduce risky actions, and to prevent the taking of major risks that are avoidable. There are few clear-cut answers in this uncertain area - to such problems as how to prevent irreversible impacts - but the least we should require is that policy be open to, and willing to consider, general information with which to anticipate the future, since few accurate predictions are available. As Holling says of irreversibilities:

We cannot always require a complete return to starting conditions or complete freedom to reach any other conceivable condition. But we can try to keep from getting locked into any one situation. No guarantees exist, but to ask honestly what options are being foreclosed reorients the planning and development process and makes dead ends less likely (1978, p.138).

Denial of information about risks is the antithesis of this honest questioning process. Systematic denial, like bias, may be a procedural characteristic, stemming from the reasoning model used in policy. The systematic refusal to consider, as a result of such reasoning, information about the future that did not comprise precise prediction would constitute procedural irrationality in the policy.

An adaptive process requires *feedback* : once new (better) information is acquired, it should be responded to by an appropriate change in the relevant system's behaviour, based as this has been on now outdated information. Feedback is important in dynamic, uncertain situations where rational behaviour, in the absence of significant accurate prediction, depends on the ability to learn from inevitable errors and adapt to unforeseen changes: iterative feedback allows successive approximation towards the most rational (fully adaptive) behaviour possible, which typically is not reached before a disruption sets the whole learning process in motion again [9]. Ideally (and in a completely flexible system), the process should be one of continual monitoring and feedback, the new improved information revealed by monitoring feeding back to improve the system's behaviour, which then produces (more rational) effects which are themselves monitored and the information fed back, any errors reduced, and so on.

We can assume that public policy changes in a democratic political system, at least to an extent, in response to democratic pressures, which mould it into a shape more consonant with social goals and values. Such adaptive changes occurred in government policy towards salmon farming (see Chapter Two). Assuming that these changes were made in response to improved information (about how to meet social goals), and were not merely cosmetic, the normative question about government policy is not whether it was adaptive (responsive to new, better information) - it was forced to be - but whether the response came without unnecessary delay. Delay, which could be partly the product of an inflexible policy model, would incur unnecessary costs or risks.

The normative criteria for policy which I have just outlined - lack of bias and denial of risks, and timely response - are somewhat minimal requirements for procedural rationality, or 'appropriate adaptiveness', for the following reason. I said earlier that I would try to preserve the 'no free lunch', or opportunity cost insight of economics in my analysis. This insight highlights the fact that there would be large information costs if an adaptive procedure such as Holling's for environmental assessment and Simon's for business

planning, with their rigorous search requirements, were prescribed for the much more complex area, and larger scale of application, of government policy. By way of contrast, perhaps the most significant economic feature of the market system, as portrayed by Hayek. is the efficiency with which it acquires and communicates information necessary to permit closer fulfilment of social goals: it does not involve the expensive and futile attempt at comprehensive data collection necessitated by central planning. This level of complexity that of the national and regional economy - is closer to the scale at which public policy (the concern of this thesis) operates, and search costs for deliberate planning at this level are likely to be far more onerous than those that figure in the two more limited adaptive models [10]. Clearly, particularly at the early, crucially formative stage for B.C. salmon farming policy, there were absolute limits on government spending; and a rigorous search procedure involving extensive government data collection, monitoring and communication would probably have meant violating those limits. However, as Holling notes, information has a value (in contributing to the fulfilment of social goals) as well as a cost; and the rational procedure would have been to weigh this judged value carefully against the costs, within the limits of budget constraints. (Government coffers were not, of course, actually 'empty' even at this early period, as the spending at the same time on industrial promotion indicates [11]: see Chapter Five. There was room for a variety of apportionments even within severe budget constraints.) Thus, lack of bias against acquisition of any significant information, as already defined, is a realistic requirement for policy procedural rationality, even in these circumstances of recession and 'belt-tightening'. Furthermore, the other requirements - of not denying risks, and timely response to new information - do not incur information costs at all: information can only be denied if it already exists and does not need to be sought; and
response, according to the analysis offered above, would anyway have occurred sooner or later, the actual timing making no necessary difference to any costs incurred.

## <u>Notes</u>

[1] Arguably, one symptom of the disorder that has characterized the industry's growth has been the lack of formalized, independent conflict resolution. The following comment illustrates the polarization and partiality of argument that have been typical during the development of B.C. salmon farming: "With no expert, independent, and binding appeal tribunal to adjudicate competing claims, opponent and proponent may utilize every political, legal, or economic weapon at their disposal to advance their respective interests, the result often being that no one's interests are well served" (Owen, 1988, p.5).

[2] Indeed 'adaptability' is the main rationalization for laissez faire - the approach that has apparently characterized salmon farming policy: see Chapters Two and Four. Since government apparently used this approach, it presumably agreed that an adaptive policy was appropriate.

[3] I shall explain these terms more fully later in the chapter.

[4] Of all the social sciences, academic economics has probably had the greatest influence on actual government policy: "... economics has developed distinctive... models and methodologies for policy analysis that have been most widely influential in policy making. Indeed, in the area of national economic policy this influence has been so great that Western economies can be said to have been restructured to fit the theories and methodologies of economists. Encouraged by this success, economists have broken out of their traditional segmental concern with the economic sector alone and are applying their approach to an ever-widening range of policy problems" (McCall & Weber, 1984, p.159).

[5] These theories, or 'models', of course, are not rigid, monolithic entities, but it is possible to draw out their essential, 'basic' features - uncontested 'core' characteristics - even in the pragmatically-oriented provincial budgets of the period.

[6] As neoconservative economist Friedrich Hayek puts it, "... science aims at the discovery of what are sometimes called 'general facts', which are regularities of events. Science concerns itself with unique, particular facts only to the extent that they help to confirm or refute theories" (quoted in Nishiyama & Leube, 1984, p.256).

[7] As Bartlett puts it, "in the sense of 'cognitive processes and procedures used to choose action', the notion of procedural rationality broadly construed has particular relevance to public policy making" (1986, p.226). In fact I shall apply the term "procedural rationality" to government policy synonymously with, and as a shorthand version of, "appropriate adaptive policy in ecological terms": if rationality is a style of behaviour that is appropriate to the achievement of given goals (Simon, 1964, p.573), and the 'given' goals for government policy lie in the furtherance of societal welfare, including prevention of significant damage to ecological resources, then 'procedurally rational government policy' is the same thing as 'appropriate adaptive policy in ecological terms'.

[8] Under this definition of rationality, which most generally means, as the *Oxford English Dictionary* puts it, 'the quality of possessing reason', "reason may be defined as one's capacity to shape one's belief and conduct to accord with one's knowledge of the world, and if one's knowledge is insufficient, the capacity to set out to acquire more knowledge pertinent to the issue in hand" (Allport, 1937, p.172).

[9] Simon provides an ecological (adaptive) analogy for the human learning-and-response process: "... [because of] the frequency of major disturbances to equilibrium... many ecologists believe that the plant communities actually observed in nature are quite as often transitional, nonequilibrium states as they are equilibrium climax communities in which only the very fittest have survived. A theory of these communities, then, requires a theory of the dynamic processes of adaptation, as well as a theory of the static optimum [with which conventional economics is concerned]" (1978a, p.505 (footnote)).

[10] Even at the 'lower' level of AEAM, though, Holling is perfectly aware of information costs, prescribing *selective* search - collecting only those types of data judged relevant - to address the problem; and the same information cost constraint can readily be incorporated into Simon's procedural rationality, which is "... the effectiveness, in light of human cognitive powers and *limitations*, of the procedures used to choose actions" (1978, p.9; italics added).

[11] For example, according to <u>The Fisherman</u> (18/7/'86), the Department of Fisheries and Oceans spent \$2.8 million on aquaculture *industrial* research and development in the year ending March 1985 - when general government restraint policies were still operative.

#### CHAPTER TWO

# SCOPE OF "POLICY TOWARDS ECOLOGICAL EFFECTS OF SALMON FARMING IN B.C."

As I said at the beginning, the first purpose of this thesis is to achieve some form of simplification for improved understanding of relevant salmon farming policy. This necessitates some definitions, or at least delineations, before going on to a fuller analysis [1].

### Ecological effects of salmon farming

I propose to concentrate on the net-pen stage of salmon farming - the 'grow-out' phase during which juvenile salmonids are reared to adulthood and marketable size in salt water. This excludes the preliminary, hatchery stage, which takes place in freshwater. All net-pen salmon rearing operations in British Columbia have some common features: private ownership, similar technology and similar siting requirements. The relative homogeneity of net-pen rearing - which is the most important area of, and indeed virtually synonymous with, "salmon farming" - simplifies the complex task (as indicated below) of identifying and describing relevant government policy, and permits some necessary generalization about "ecological effects".

The latter consist largely of *risks* of various types (as detailed in Chapter Three). The nets that enclose the farmed salmon are prone to periodic breakage, and escapes are common; large quantities of fish wastes and uneaten feed, and significant quantities of the chemicals used in husbandry and maintenance of facilities, enter the surrounding environment. Net-pen farms have required sheltered sites and proximity to shore, often

being located in coastal inlets; they are therefore likely to be located in the vicinity of salmon-bearing rivers and streams and close to the migratory routes of wild salmonids, and may often be in relatively enclosed waters where concentrations of the various wastes produced could affect the local ecology and other (non-salmon farming) human uses of these valued areas.

The most obvious risk incurred by the intermixing of wild and escaped farmed salmonids is the transfer to wild stocks of exotic pathogens imported with the farmed fish; the damage to wild stocks from exotic disease transmission, as Norwegian experience bears out, could be catastrophic, but no such transfer is known to have taken place (though an important exotic pathogen (VHS), which *might* have derived from salmon farm importations, was recently detected in wild stocks in the Pacific Northwest). There is also a risk that the adaptive genetic traits of wild stocks could be 'diluted' by interbreeding with farmed salmonids selected for commercial genetic traits. As for waste products, a variety of potentially deleterious substances *are* known to have entered the natural environment, but their effects there are poorly documented [2], and depend to some extent on whether the farm has been sited to take advantage of aquatic dispersal and dilution to ameliorate them [3].

Net-pen salmon farming has thus given rise to risks in the form of significant potential ecological costs (which apparently, though, have not yet come about); and may - on the evidence of the potentially harmful introductions to the environment that have undoubtedly been made - have incurred significant costs of which we are as yet largely ignorant. So, as I said before (p.17), salmon farming in B.C. has threatened significant ecological resources, the protection of which is an important social goal; and given

government's responsibility to further collective social goals, protection of these resources should have been a significant concern of government policy. That, certainly, was the conclusion of the Gillespie Inquiry, the single major public debate on the issue, which recommended substantially-increased government attention to the environmental question (Gillespie, 1986, pp.36-40). The social importance of protecting B.C.'s large wild salmonid stocks is indicated in most relevant policy documents; thus the 1982 Commission on Pacific Fisheries Policy stated that "fisheries policy must first and foremost ensure that the resource is properly protected and, whenever advantageous, enhanced" (Pearse, 1982, p.4). And there can be little doubt of the social value attached to the avoidance of significant marine degradation; ecological protection is a prerequisite for much of the B.C. coast's economic and social life. As a B.C. Ministry of Environment policy document put it:

Both fisheries and mariculture [sea farming] are based on renewable resources. Sound resource management, coupled with effective environmental protection and economic development policies, will help to ensure expanded and continuing job and income opportunities (ME, 1980, p.1).

In fact it is not necessary to labour this point. The ecological resources of inshore marine environment and wild salmonid stocks - significant damage to both of which has been risked by salmon farming - obviously have important social value in both economic and aesthetic terms.

## Government policy

I have already mentioned the difficulty of positively identifying government policy relevant to the ecological effects of salmon farming development in British Columbia. There are a number of reasons for this lack of clarity.

Perhaps the most obvious is the jurisdictional muddle involved; as the 1988 B.C. Ombudsman's report on the industry concluded, "out of this inter-jurisdictional maze, one clear fact appears: no single level of government - local, Provincial or Federal - emerges as having total jurisdiction" (Owen, 1988, p.13). Most salmon farms in B.C. have been located in sheltered coastal inlets and island passages, which are classified as "internal waters"; the management and sale of the resources of these areas falls under the jurisdiction of the province (ibid., p.10). But the federal government retains some jurisdiction in these areas under the federal Fisheries Act [4], administered by the Department of Fisheries and Oceans (DFO); the statute's purpose is to prevent destruction of fish habitat and "... the dumping or placement... of 'deleterious substances' which would have the effect of harming fish habitat or wild fish stocks" (ibid., p.11). Accordingly, DFO has until recently required that salmon farms obtain a licence under Section 7 of the Act (ibid.). Even so, the primary jurisdiction over salmon farming and any ecological effects it might have has fallen to the province (which indeed challenged the constitutional standing of the DFO licence (ibid.)). The Ministry of Crown Lands (MCL) has nominally been the primary Provincial regulatory agency, allocating aquatic Crown land under the B.C. Land Act [5]; but many of the provisions of the salmon farming leases and licences it issues are in effect administered. under a 'referral' arrangement, by other agencies, primarily (what is now) the Ministry of Agriculture and Fisheries (MAF), MCL's lead referral agency, and, to a lesser extent, the Ministry of Environment (ME). DFO has also been, and is now primarily, a contributor to MCL's referral process (ibid., p.11).

The responsibility over ecological effects of salmon farming, then, has fallen somewhere between these four agencies. The Ombudsman's report puts the overlap down to

the novelty and multi-sectoral complexity of salmon farming: "... fish farms appear to be operational anomalies over which, because of overlapping jurisdictions by a variety of federal and provincial agencies, it is difficult for any one body to regulate specific impacts" (Owen, 1988, p.34). Ecological impacts could derive from siting and husbandry operations (primarily the concern of MAF, but with lesser, discretionary inputs from DFO and ME); from waste products of operation in general (latterly the concern of ME); and from biological transmissions from escaped salmon (the concern of DFO and ME). (This complexity of possible ecological impacts and their origins is not, I would argue, unusual indeed it is implied in the ecological systems concept - and, as I shall indicate later, the (perhaps unavoidable) overlap of government responsibilities was not a primary influence on, nor legitimate excuse for, any neglect of ecological concerns by government as a whole.)

The second reason for the difficulty of simple definition of government policy relevant to salmon farming's ecological aspects has to do with time. Salmon farming in B.C. was only a very minor industry until 1984, whereafter it expanded very rapidly (see Chapter Three). During this period of development (1984 onwards), not only did agency jurisdictions change for administrative reasons, but - more significantly - the December 1986 Gillespie public inquiry brought about extensive administrative changes (Owen, 1988, p.37), including the devolution to the ecologically-mandated Ministry of Environment of considerably expanded responsibilities over salmon farming (ibid., p.30). The Inquiry resulted, then, in substantial changes - which we can take to have been improvements (ibid., p.37) - at least in the detail of government policy relevant to salmon farming's ecological aspects. In other words, relevant government policy *evolved* over time: hence some of the difficulty of delineation. Indeed, according to some distinguished

political theorists, "... policy is actually made not by a policy maker but by *interaction* among a plurality of partisans" (Lindblom & Cohen, 1979, p.64; italics added): government policy is often to a large extent the 'evolutionary' product of interacting forces - pressures applied by different interests and arising from experience of events - which have a far greater effect than the cogitations of ostensible decision-makers and planners within government. And in this case, the external pressure of events and public participation - most significantly in the form of the Gillespie Inquiry - *does* appear to have transformed government policy. But of course this does not mean that the deliberations of (broadly-defined) government 'planners' did not have *some* significant effects on 'real' policy - as reflected in government actions rather than mere rhetoric - especially early in the development process before the interactive 'correction' of the Gillespie Inquiry. Holling argues that this stage may actually be particularly important:

... the fundamental properties of any development or policy are set very early in the design stage. If problems arise because the original context was too narrow, any fundamental redesign is extremely difficult unless there is extraordinary pressure. Confrontation is guaranteed as different groups identify clear conflicts with their own interests. Confrontation and public debate are essential dimensions of the development of policies, but if the issues emerge only because the design phase was unnecessarily limited, economic enterprises offering legitimate social benefits can be halted and opportunities for husbanding and enhancing man's natural endowment can be subverted (Holling, 1978, p.6).

The early, or 'design' stage of policy, may be crucial in that it will set in train irreversible courses of events. So the policy design should attempt to avoid commitments that may cause irremediable damage. The challenge at this stage is not only to avoid costly irreversibilities, however, but more generally to create or utilize a scheme for rational action in the face of uncertainty - before the experience necessary for learning (ie. reducing uncertainty) is acquired. It is at this stage that an analysis of "procedural rationality", the general normative criterion of the thesis introduced in Chapter One, is most appropriate: at the stage of policy formulation prior to 'correction' by interactive, arational forces, at which analytical deliberations - 'rational' in the sense of cognitive or 'reasoned' - are likely to have most effect. At this stage, in other words, reason is particularly important in policy formation, and it is appropriate to prescribe improvements in rationality. I shall therefore concentrate in this thesis, at least in normative analysis, on government policy towards salmon farming during the period of development leading up to the Gillespie Inquiry. This period is anyway particularly significant in the industry's overall development, even to the present time, since the majority of salmon farm tenures (determining siting, for example) were issued under pre-Gillespie policies (The Fisherman, 12/12/86), and some important Gillespie-inspired policies on operation (with ecological repercussions), such as the Aquaculture Waste Control Regulation of December 1988, did not come into effect until quite recently. The pre-Gillespie period - what might be called the planning stage for the industry - was crucial in the development of salmon farming in B.C..

But relatively little planning seems to have taken place. Indeed the paucity at this stage of reasoned deliberation about the future of the industry (such rational articulation of thought being a hallmark of public planning) is the third and most important reason for the difficulty of delineating relevant government policy. Thus the 1988 Ombudsman's report complains repeatedly about the continuing lack of direct salmon farming legislation, which of course would be openly, publicly articulated:

There are virtually no Provincial statutes or regulations which have been created in

direct response to the growth of the industry. This has created a situation in which anyone wishing to establish a fish farm, or object to a fish farm, must contact the appropriate Ministry, which may in fact have control over only one aspect of the farming operation, to find out what the government policy is (Owen, 1988, pp.27-28).

The Gillespie Inquiry similarly emphasized "the lack of a clear, comprehensive and integrated policy on [salmon farming] aquaculture..." (Gillespie, 1986, p.9).

The deficiency of articulated, comprehensive planning remarked upon in the two reports does, of course, provide a clue about the general orientation of salmon farming policy: the omission - deliberately, of central planning - is a principal feature of the ideology of laissez faire [6]. As I have already mentioned, the economic climate of the early and mid-1980's saw an increased emphasis on 'market solutions', in line with this ideology. So as a first step in the necessary attempt to identify 'government policy relevant to ecological aspects of salmon farming' [7] - in the relative absence of any significant public planning to help us do so [8] - we can assume that that policy contained some of the characteristics of laissez faire. But this assumption only provides the vaguest of directions in the identification process. Since more specific details of policy were not directly articulated - as is the nature of laissez faire - we must look for inferences of them in the wider context.

It is worth emphasizing here the seemingly paradoxical nature of laissez faire policies. The 'philosophical' basis of laissez faire is fully rationalizable; and a major thrust of this reasoning is that reason alone is a severely limited tool for the achievement of social welfare. The rationalism of central planning - the belief that reason, in the form of deliberate, calculated organization, is sufficient to meet all social needs - is viewed as hubris, and the policies based on it as inefficient, inflexible [9], and ineffective. The

market system, by contrast, is largely autonomous, or arational, in the economic field: "resource allocation by buying and selling requires no decision *about resource allocation* by anyone, nor need anyone articulate the problem of resource allocation or articulate the answer" (Lindblom & Cohen, 1979, p.26). Nobody, under the market system, decides or deliberates about how to allocate resources: market exchange - the famous Invisible Hand just does it. According to laissez faire, the economy should operate with a minimum of formal deliberation, articulation and decision-making: such planning is anathema to it. So laissez faire policies are unlikely to be accompanied by comprehensive, detailed projections and calculations for industrial development - the market, it is believed, will achieve most of this efficiently and automatically. We should not look, therefore, for formal deliberations and plans to define all the details of policy under laissez faire. Instead, we may have to infer many of the details from the policy context: here, at least - at the level of general policy framework - we can find reasoned deliberation.

An effective expedient for setting the economic policy context, for Canada as a whole and at the relevant period, and a coherent analysis of the general policy framework, is the 1985 Report of the Royal Commission on the Economic Union and Development Prospects for Canada - the Macdonald Report. A further expedient, this time for establishing the economic policy context specifically for British Columbia, is the Provincial budget speeches of the early 1980's, the period of the B.C. government's "restraint" program. The budgets, though obviously pitched at a more pragmatic level than the Royal Commission, also contain a relatively coherent and articulated rationalization of general economic policy.

To summarize briefly the policy orientation of the Macdonald Commission, it primarily recommends a shift in the balance between the private exchange market and the

welfare state in the Canadian economy, to favour the free market. The reasoning behind this is basically that the market, through the 'discovery mechanism' of competition and the efficient co-ordination of the price system, is the preferred means for adaptation of the economy to substantially increased competitiveness, productivity, and thus growth. By the same token, the welfare state is seen as having grown unnecessarily large and inefficient, and should therefore be reduced in size and its 'productivity' improved. The Commission sees a role for government, as administrators of the welfare state, in correcting negative 'side-effects' of the market, including ecological 'externalities' (a term deriving from neoclassical welfare economics).

B.C. economic policy as articulated in the budgets of 1983-85 manifests the same basic concerns - the intention both to strengthen 'the market' to improve economic growth, and to minimize levels of government spending. But there is considerable latitude within these shared aims - different means of achieving them and even different definitions of their terms. Taken as a whole, for example, B.C. economic policy does not readily conform to the prescriptions of neoclassical economics, which the Macdonald Commission's recommendations approximate more closely. The basic neoclassical prescription for the balance between market and state is as follows:

In a wide range of activities, economic efficiency is best served by profit oriented businesses and relatively unfettered private markets. But there are also many cases where economic efficiency requires intervention by the state to protect the well-being of individuals from the effects of unrestrained private actions (Kesselman, 1986, p.80).

In contrast to mainstream neoclassical theory, the Provincial government stance during the period, according to this neoclassical commentator, was characterized by a "... favourable

regard for public policies which benefit the business sector even if they distort product markets or give producer groups monopoly powers" (ibid., p.79): the aim was not in fact to strengthen 'the market' in the sense of improving its structure by making it more competitive, but to support business. And since it was perceived as detrimental to business, government intervention, prescribed by neoclassical theory to correct market externalities, was repudiated. Kesselman concludes that the B.C. government's ".... mini-efficiency approach lacks a clear understanding of the principles of economic efficiency as they apply to a complex world with externalities and other departures from perfectly competitive assumptions" (p.96). "Mini-efficiency appears to be a descendant of neo-conservative economic thinking in the United States. However, the Social Credit administration has given its own special twist to the minimal government perspective. Their innovation is the view... that policies favourable to the business sector must necessarily be economically desirable. It is unclear whether the... approach stems merely from political calculation rather than philosophical principle. Or could it be due to an incomplete reading of the works of neo-conservatives such as economist Milton Friedman or more locally the Fraser Institute?" (pp.80-81).

We should expect 'government policy (federal and provincial, to reflect the overlapping jurisdictions) relevant to ecological aspects of salmon farming' to be located *somewhere* in the general policy context provided by the above two sources (the Macdonald Report and the 1983-85 B.C. budgets). Though there are inconsistencies between them, and internally within B.C. economic policy as set out, the influence on both of some core ideas, or systems of ideas, is easily discernible. As I said before, there is evidence that salmon farming policy was, in an imprecise sense, a laissez faire one. The laissez faire ideology

prescribes minimal government and maximum reliance on the market for economic adaptation and growth. These features, which are hallmarks of neoconservative economic theory, are evident in (what we can take to be) both the federal and provincial economic policies. We can probably even say without too much inaccuracy that those policies were primarily neoconservative ones. Though neoclassical theory has in common with neoconservative economics the apotheosis of the market, it is not necessarily opposed on principle to the state - indeed a significant portion of the neoclassical sub-field of welfare economics is devoted to prescribing state actions. It does not prescribe minimal government - at least not nearly with the vehemence of neoconservative theory - and that, together with the market emphasis, is the primary feature of both the Macdonald and B.C. budget prescriptions. So it seems adequate to describe those prescriptions, and the federal and provincial policies, as primarily neoconservative; it is only when we turn to the ineradicable reality of the modern welfare state - the repository of abhorrent central planning, for which neoconservative theory can make no positive prescriptions - that distinctively neoclassical theory must be called upon, almost by default. Under the laissez faire ideology.

... the economist's analysis of the *public sector* follows the strictures of *neoclassical* thought in deducing models, analogies, and criteria as guides for the formulation of public policy, with the initiatives, outlook, and opportunities for public action understood and explained as no more than residuals in an occasionally imperfect universe of private choice and market exchange (Solo, 1975, p.111; italics added).

Given the importance of these two, overlapping systems [10] of thought in general economic policy of the early 1980's, it is possible to get closer to a definition of 'government policy relevant to ecological effects' by singling out some of the two systems' core ideas ("models,

analogies and criteria").

In <u>neoconservative</u> theory, the primary economic goal of maximum growth is best achieved by competition and the price system. The 'discovery mechanism' of competition is an evolutionary metaphor: firms operating in a competitive market supposedly will prosper if they provide a product or service required by the economic system; otherwise they will fall by the wayside. It is survival of the fittest. The constantly changing economic environment 'selects' firms according to their 'fitness'. Firms respond to this constant change by discovering new ways to meet the system's requirements. They can only make these discoveries if they risk failure. So competition, which provides the freedom to make discoveries and at the same time necessitates risk-taking, is a trial-and-error discovery mechanism. The price system, meanwhile, communicates information between producers and consumers and co-ordinates their decisions, which ensures an effective response to the changing requirements (changing supply and demand conditions) of the economic system, and the increasing satisfaction of consumers' material needs and wants (growth), without the need for costly central planning. Government need only set the rules to ensure fair play in the competitive game.

But of course the modern social system demands that government do far more than this. It must answer to collective values that the market cannot, or does not, meet - such as welfare, environmental protection and defence. It must raise taxes and set trade policy, and in doing so will inevitably interfere with the market. Even under laissez faire, state action in a variety of areas is a fact of life, and this is where what I have called 'distinctively' <u>neoclassical</u> prescriptions need to be employed. Since an overall aim is to minimize government, neoclassical marginalism can be used to calculate and improve government (the

bureaucracy's) productivity, or efficiency, making it 'leaner' (smaller). At the same time government can manipulate or otherwise make use of private incentives to further collective goals - thereby working *with* the market, the driving force of which is private self-interest, and minimizing necessary market interference. And according to neoclassical welfare economics - though under laissez faire this should be a last resort, when all market options have been exhausted - government can even intervene in the market to regulate (reduce) negative externalities.

These fundamental models and ideas can be seen in operation in government policy relevant to ecological aspects of salmon farming [11]. Under the <u>neoconservative</u> head, it is possible to detect an argument made by government in favour of a 'trial-and-error discovery' process whereby salmon farming firms would 'learn' the most profitable operating conditions by being allowed virtually unrestricted siting opportunities. The industry as a whole would learn from the mistakes of those who sited badly. If this trial-and-error process suggests some disregard of the ecological damage it might incur - in that it would not necessarily be in firms' interests to learn about such damage (but see below) - that problem could be handled by the regulating price system: consumer sovereignty would ensure that the citizen's taste for environmental protection was satisfied.

Ecologically-relevant government arguments evidently influenced by <u>neoclassical</u> theory can also be found. The first is that bureaucratic efficiency could be improved by applying basically marginalist criteria. Marginalism is a determinist prescription: it disregards uncertainties. Only those government services should be provided that were 'essential' - ie. that produced a *known* social welfare 'product'. The implication is that government services with an unquantifiable and/or not wholly predictable product - such as

education, or research into ecological uncertainties - should be cut or not funded at all. Secondly, salmon farms were regarded as being highly sensitive to water quality; operators would be foolish to locate in areas with known industrial pollution. The argument that apparently followed from this was that they would be ecologically 'self-policing', since it was in farms' self-interests not to pollute *themselves*. No government ecological regulation was therefore necessary. The argument is apparently based on the neoclassical conception of 'incentives', which derive from 'rational self-interest', and is at best simplistic. Thirdly - though this argument is a late addition, arising *after* substantial regulatory interventions had been forced by the Gillespie Inquiry - the neoclassical prescription of government intervention to redress negative (common property) externalities was apparently invoked.

Unfortunately, having got this far in the simplification process, it is now necessary to introduce two factors that add once more to the complexity of 'relevant government policy'. First, the policy conceptions derived from academic economics are likely to be simplistic interpretations that may not fully conform with the academic formulations - which makes my analysis of policy via the heuristic of the two academic 'models' more complex. Second, and more importantly, the policy conceptions (such as 'market regulation' through consumer sovereignty, or 'self-policing') may have been as much legitimating after-the-fact *arguments* as substantive influences on government actions. We know that actual policy, as reflected in government actions rather than mere rhetoric, "... often emerges from a welter of conflicting influences..." (Lindblom & Cohen, 1979, p.34), not principally academic ones, and indeed "... one might argue... that academic social science is no more than window dressing for policy strategies chosen on other grounds. Or that it only

marginally strengthens of refines policy-making frameworks chosen on practical arounds..." (ibid., p.77). The policy conceptions I have identified, derived from academic ideas, may indeed have served partly as political 'window dressing' - to camouflage what Kesselman describes as the naively pro-business attitude of the Provincial government [12]; and to present a face-saving rationalization of the lack of any coherent policy [13]. These factors were almost certainly important influences on actual policy outcomes relevant to ecological effects - where I mean by 'policy outcomes' deliberate government acts or omissions, such as in providing regulation and research, or failing to do so. These outcomes, representing the real as opposed to the merely rhetorical face of government policy, are the ultimate concern of this thesis. But I must assume that the ostensible policy (so far as it is ostensible!) had some influence on such outcomes - that it was integral to them, or at least one of their contributory influences, though it was not their sole cause. Purely political considerations may have been another influence on, or cause of, the same phenomena, but such manoeuvrings are outside the scope of my analysis: I am concerned with the rationality - the appropriateness for achieving given goals - of government policy, the legitimate goals of which comprise the furtherance of societal welfare, including ecological protection. Political intrigue has different goals: it is not intended to be a means to the same ends (societal welfare), and is therefore not likely to be appropriate to achieving them. My analysis is only concerned with government policy which can be rationalized as a means to the legitimate ends of public policy.

# <u>Notes</u>

[1] This chapter is intended to be an introduction to, and preliminary summary of, chapters 3 to 5, where the factual statements made here are more fully referenced.

[2] For example, "pesticides which are used in the marine fish farming industry include antifoulants, fungicides, parasiticides and wood preservatives. The extent of their use by this industry has not been documented in B.C.. Marine environmental effects, including fate, persistence and impacts on non-target organisms, are poorly understood.... The same circumstances apply to therapeutants which may be used in B.C., such as fish antibiotics and hormones. Research and testing is required to ensure... environmental suitability... " (ME, 1990, p.20).

[3] "Impact of the solid waste [from salmon farms] will vary from severe in a poorly flushed, inappropriate site to negligible at a site with excellent current, depth, and flushing" (Owen, 1988, p.3).

[4] R.S.C. 1970, Chapter F-14.

[5] R.S.B.C. 1979, c. 214.

[6] As Brooks remarks of the "laissez-faire approach to policy determination", it not only does not involve specific government decision-making, or detailed planning, but expressly repudiates it (1989, p.67).

[7] I attempt to make this identification more fully in Chapters 4 & 5.

[8] With the possible, partial exception of <u>Aquaculture: A Development Plan for</u> <u>Canada</u> (ITFA, 1984): see Chapter Four.

[9] The value of *not* having a detailed, articulated - and thus rigid - plan in the early, learning stages of development is accepted in the 1988 Ombudsman's report: "It is important to state... that this office recognizes the inherently evolutionary nature of regulatory programs. Flexibility and discretion are valuable in the developmental stages..." (Owen, 1988, p.2).

[10] Although there is considerable diversity within both neoconservative and neoclassical 'systems' of thought, so that "... it may be important to separate policy advice into categories based on [subsidiary] schools of thought", nevertheless there is sufficient coherence within neoclassical theory that it has been described as "... an approach to policy questions that, for the lack of a better name, might be called *the* economic approach" (Amacher, 1984, pp.160-61; italics added), encompassing much neoconservative thinking as well, such as the shared belief in the economic efficiency of the free market.

[11] The complex academic reasoning behind these principles does not negate their influence on primarily pragmatic policy. As I noted before, it is arguably these 'basic' principles of academic economics that have by far the greatest influence on actual government policy: the ideas are so fundamental that they can become almost 'common sense', the 'ordinary knowledge' that is actually employed predominantly in policy-making. Thus "a great deal of economic knowledge, for example, from Smith, Ricardo, the Austrians, Marshall and Keynes is now detached from its sources. It has been taken up by persons who have accepted it, despite their ignorance of the evidence or argument on which it rests" (Lindblom & Cohen, 1979, p.80).

[12] 'Naive' because minimizing government functions in order to free up economic

resources for use by the private sector may harm not only other activities, but even those *within* the business sector, in that many public services are important for effective business operations (Kesselman, 1986, p.79).

[13] As Ombudsman Stephen Owen put it in late 1988, "regulation has been scrambling to catch up but it has not always been coordinated to the extent it should be" (Vancouver Sun, 10/12/'88). And there are other indications that the speed of salmon farming growth caught 'policy-makers' on the hop - for instance, at the National Aquaculture Conference in 1983, immediately preceeding the industry's 'take-off', B.C. experts judged that in salmon farming "... only cautious, slow growth can be predicted" (Bourne & Brett, 1983, p.34).

## CHAPTER THREE

#### BACKGROUND AND CONTEXT

#### Introduction

I have already alluded to the controversy and uncertainty surrounding many aspects of B.C. salmon farming - over what, if any, are its ecological effects [1], and what has been the overall government policy towards the industry's development, for instance. It is as well to begin the detailed description of the industry's development with a few undisputed facts - B.C. salmon farming's undoubtedly rapid growth, and the complex, but ascertainable, mix of government jurisdictions affecting it. This background information can be summarized fairly briefly. Next, I will attempt to establish the economic policy 'context' for the relevant period; and lastly, I will summarize and categorize possible ecological impacts. This entails a progression from less to more uncertain, or controversial, information, which I shall therefore match with progressively more detailed corroborative evidence.

## Growth of the B.C. salmon farming industry

The first marine net-pen grow-out facility for salmon in British Columbia was established in 1972 (Reddick, 1988, p.8), in the Sechelt area. Thereafter the industry grew only slowly until 1984, by which time there were ten farms; in fact production peaked at just over 270 tonnes in 1982 and fell briefly afterwards (ibid.). After 1984 rapid expansion took place, numbers of operating farms rising to about 40 in 1985, 80 in 1986, 200 in 1988, and 220 in 1989 (ibid., p.11; and MAF, 1990). Production expanded even faster, as average farm sizes increased, reaching about 390 tonnes in 1986, 1,000 in 1987, 5,800 in 1988, and 12,000 in 1989 (ibid.). In 1988, of total estimated B.C. mariculture sales of \$42.3 million, over ninety percent (\$38.5m) derived from farmed salmon (Fralick, 1988), signifying the present dominance of the industry in B.C. aquaculture.

# Government jurisdiction over ecological aspects of salmon farming

Government jurisdiction over aspects of net-pen salmon farming that could affect the ecological 'environment' has changed repeatedly over the relevant period (the 1980's), and shifted uncertainly between federal and provincial levels. As owner of all Crown land in British Columbia (Dorcey, 1983, p.24), the province has taken the leading role in salmon farm administration:

At present, all foreshore lands and submerged lands found in bays, inlets and other water *inter fauces terrae* (within the jaws of the land) are provincially owned. In addition, the Supreme Court of Canada has ruled that all submerged lands between Vancouver Island and the British Columbia mainland also belong to the province [*Atty.-Gen. of Canada v. Atty.-Gen. of B.C.*, (1984) 8 D.L.R. 161 (Supreme Court of Canada)]. The protected nature of the waters associated with provincially owned submerged lands has made them the most desirable for salmon farming, thus explaining the province's leading role in site allocation [etc.] (Reddick, 1988, pp.27-8).

Under the B.C. *Land Act*, the B.C. Ministry of Forests and Lands ("MFL"; before 1986, the Ministry of Lands, Parks and Housing) has been responsible for the administration of aquatic lands for salmon farming, granting lease and licence operational tenures (ss. 35-36). The regulatory responsibilities towards salmon farming of the other agencies involved, prior to the December 1986 Gillespie Inquiry, were as follows. Under subsidiary agreements in the early 1980's between MFL and the B.C. Ministry of Environment, the

latter's Marine Resources Branch ("MRB") was confirmed as being responsible for "... the planning, management, protection and conservation of the Province's freshwater and marine resources... and... the encouragement of maximum productivity of [its] aquaculture resources" (Gillespie III, 1986, MAF At'chm't 2, p.2) - the aquaculture functions to be accomplished primarily through review of management plans submitted by the prospective salmon farmer, which when approved would attach, with the ultimate condition of forfeiture if "diligent use" was not shown, to the lease or licence. In 1986, the downgraded Marine Resources *Section* was transferred to the B.C. Ministry of Agriculture and Fisheries (later that year becoming the Aquaculture and Commercial Fisheries Branch). The mandatory management plan administered by MRB, revised as the "Marine Fish Farm Production Plan" in September 1986 under the new agency, stipulated that

... the Commercial Fisheries Branch... review and evaluate the technical and economic aspects of the... Plan. Branch staff... will, on request, offer advice on the biological, technical and economic aspects of fish farming.... The Production Plan provides basic information on site characteristics, husbandry and production strategies and costs.... the applicant is [required to]... 1) Check the... compatibility of the desired site. Particulary important items are... proximity to salmon-bearing streams (contact: District Federal Fisheries Office).... 3) Assess the biophysical capability of the site through such measurements as water temperatures, salinity, currents and depth, and the shelter from winds and wave actions.... The lease or licence holder should show both diligent and proper use of the site by complying with the schedules of improvement and production (Gillespie III, 1986, MAF At'chm't 3, pp.2-6).

Review of the Plan by the Commercial Fisheries Branch was thus "... to extend technical information and recommendations... on site suitability...; to ensure the... Plan provides a basis for subsequent evaluation of diligent and proper use...; to advise B.C. Lands on the biophysical capability of the proposed site as a fish farm.... Suggestions regarding environmental monitoring and methods to mitigate possible siting problems may be given"

(ibid., pp.6-7). In other words, the Commercial Fisheries Branch (hereafter referred to as "MAF"), though not part of an explicitly environmental agency, at this time had jurisdiction over various aspects of salmon farming (such as siting, husbandry and monitoring) with significant possible environmental consequences. In fact, in these areas it had (and in some of the same areas still has) precedence over other agencies: "B.C. Lands considers [MAF] as its prime technical/scientific advisors in instances when there is disagreement amongst marine resource management agencies on particular applications" (Gillespie III, 1986, MAF p.3). It is notable here that MAF's role was largely in augmenting information gathered by the salmon farm applicant, and in supplying advice, at its own discretion.

MAF's input to salmon farm tenure regulation, like that of the B.C. Ministry of Environment ("ME"), was thus as advisor to MFL, under the latter's referral system. The Federal Department of Fisheries and Oceans (DFO) might likewise be consulted; though "DFO does, of course, have a legislative mandate for the protection and conservation of fish and shellfish resources, their habitats and the fisheries they support [, t]he Land Referral system provides DFO with an opportunity to advise B.C. Lands on the fisheries implications of each application for Crown land" (ibid., p.1). Under the federal *Fisheries Act* and other federal regulations, DFO required applicants to obtain an Aquaculture Licence, the conditions of which "... try to anticipate environmental and disease problems which might negatively affect both the wild fishery resource and habitat and the aquaculture venture, and... are structured to prevent or minimize such negative effects" (DFO, 1987, p.2). Licences might be modified, suspended or cancelled if aquaculture facilities were found to have significant adverse effects on fish stock or fish habitat, or if diseases that posed a hazard to fish stocks

or adjacent aquaculture facilities were not reported (ibid.). DFO also required an Import Permit for importations of live salmonids from outside B.C. for aquaculture purposes, and, with ME (together comprising the Transplant Committee), a Transplant Permit applicable to transfers of stock within B.C. - both permits being designed to prevent introduction and spread of salmonid diseases (ibid. pp.13-19). Finally, the applicant must obtain from ME a Waste Management Permit, required if septic waste was to be disposed of at sea. (See Appendix I, "1986 (pre-Gillespie Inquiry) B.C. salmon farm licensing structure".)

Significant changes to this regulatory regime occurred following the recommendations of the Gillespie Inquiry, which reported in December 1986. Although, it recommended, the MFL referral system should continue, being of value in identifying site limitations and establishing management provisions to be attached to tenure (Gillespie, 1986, p.43), and the multi-agency approval framework, utilizing a variety of existing legislation and administrative agreements between agencies, should be maintained, MAF was to clarify and expand its role as lead agency (ibid., p.49), and the provincial and federal governments should streamline their overlapping regulatory requirements (p.30), particularly those relating to site approval (p.44) - DFO's Aquaculture Licence and MAF's Production Plan. Further, ME should establish a mandatory environmental monitoring system for each aquaculture site and surrounding area (p.36).

In response to the Inquiry, the *Aquaculture Waste Control Regulation* (Dec. 1988) established regulatory requirements (within the ME mandate) for salmon farms under section 35 of the B.C. *Waste Management Act* [S.B.C. 1982, c.41], including the need for (or exemption from) Waste Permits and participation in an environmental monitoring and reporting program, as recommended (ME, 1989, p.1). In September 1988 a

"Memorandum of Understanding on Aquaculture Development" was signed by the federal and provincial governments, agreeing that MAF was to issue a new Aquaculture Licence (effective from October 1989 with the implementation of the *Provincial Aquaculture Regulation* under the B.C. *Fisheries Act* [R.S. 1979, c.137]), DFO's input into licensing now being exclusively through the referral system (MOU, 1988, pp.2-3). DFO could still exercise its mandate under the federal *Fisheries Act* , *Fish Health Protection Regulations* , etc., but agreed to consult with the province on matters pertaining to those regulations, on introductions and transfers, etc. (ibid., p.4). This is substantially the jurisdictional position in 1991. The Transplant and Import Permits retain much the same form as previously (but see Chapter Five for later modifications of details of the Import Permit). (See Appendix II, "1989 (post-Gillespie Inquiry) B.C. salmon farm licensing structure".)

### Economic policy context

A good starting point (as noted above) from which to begin to outline the economic policy context relevant to B.C. salmon farming is the Report of the Royal Commission on the Economic Union and Development Prospects for Canada ("the Macdonald Commission"; Macdonald, 1985). The Commission was set up in November 1982 (immediately following the most severe phase of a major economic recession in Canada), and reported in August 1985 after gathering information from extensive research and numerous public hearings across Canada - its proceedings thus coinciding with the decisive period in the acceleration of the growth of B.C. salmon farming, and part of its mandate being the recommendation of "the appropriate national goals and policies for economic development" (ibid., p.xvii), thus including salmon farming development.

The intellectual, or even 'philosophical', stance taken in the report is fairly clear and

coherent. Though

... the Commission proposes no single ideology to encompass answers to the many questions on the agenda [, n]evertheless, the need to address the larger, interdependent contexts in which we live must be recognized.... The attempt to understand [that interdependence]..., and, in particular, its consequences for Canada's institutional arrangements, contributes a minimum intellectual coherence to the particulars of our public life (Macdonald, 1985, Report Highlights, pp.5-6).

Thus the Commission avows a "... general advocacy of enhancing market forces and the

competitive capacity of the Canadian economy" (Macdonald, 1985, Vol.1, p.57), apparently

drawing heavily on neoclassical economic theory, set against a political science background:

We agree that economic analysis is a powerful tool to explain the costs of impediments in... markets and to suggest appropriate directions for reform. It is the Commissioners' belief, however, that an explanation of how those rigidities developed and how they can be overcome requires an expanded perspective which locates developments in... markets in the context of the socio-political process, out of which they emerged and through which they can be modified" (ibid., p.56).

There is the repeated unqualified assertion to the effect that "capitalist markets are...

efficient instruments for the performance of economic activities" (p.45); in other words,

an embrace of the price system for resource allocation:

In the Western world... markets have been organized by the price system, which transmits cues to the buyers and sellers of goods, services, labour and capital. In the contemporary mixed economies and welfare states of Western industrial democracies, most economic decisions - to buy and sell, to invest,... [etc.] - are made by private actors in market situations. The market allocates resources impersonally to their most profitable use in a context of consumer sovereignty (p.41).

There is also rather unquestioning acceptance of the political desirability of the market

system:

Democratic states and free markets need one another. The market performs valuable political functions, in addition to economic functions, for society, and thus greatly reduces the demands on the state. The primary political contribution of markets is that they locate essential decision-making processes concerning production and consumption in private hands, within a framework which, in general, provides a broad "accountability", or responsiveness to the consumer. Accordingly, markets reduce the knowledge requirements and managerial obligations of government. Secondly, markets generate the economic product from which the state can extract resources for the pursuit of its varied objectives. Thirdly, markets contribute to political freedom by providing a realm of autonomy, outside the detailed reach of the state, to which individuals can retreat when they are out of favour with political authorities. Market economies decentralize and diffuse power (p.43).

Of course, "markets do not exist in a vacuum" (p.41); "markets and states are deeply intertwined in the modern world. The state plays many roles, some of which have a significant impact on the economy even when their purpose is not explicitly directed to modifying economic performance" (p.43). The inequitable distributional consequences of the market system can legitimately be addressed by government:

... employing democratic processes, citizens challenge the market distribution of power and income; they use the state to impose criteria of equity which modify market outcomes. The result is the welfare state, an embodiment of concepts of sharing which subordinates market results and our status as actors in the economy, to citizenship concerns and community values....

Thus the distributional consequences of capitalist markets are deliberately altered by transfer payments and also by the collective provision of goods distributed outside the market system and often provided without charge to the citizens (pp.45-6).

The report thus sanctions state intervention in the economy for the provision of 'welfare',

including the provision of collective goods not provided by the market (and, impliedly, the

regulation of collective 'bads' produced in it, such as ecological 'externalities'). There is a

"... general consensus in favour of the welfare state and a mixed economy which is not caught

up in the fray of battle" (p.47). What is contested, however, is where the balance between

state and market should be struck. The report favours the market. The provision for

# collective values

... consume[s] resources. We properly, therefore, apply efficiency criteria to our social policy instruments and, other things being equal, prefer instruments which impose minimum constraints on market mechanisms and thus minimum constraints on efficiency....

The welfare state... is... characterized by some contradictions and unanticipated negative consequences....

... we believe that in several areas, the present division of labour between state and market, the product of decades of incrementalism, contributes neither to our economic nor to our political objectives (p.47).

The report thus advocates down-sizing of (inefficient) government: "We must seek an end to those patterns of government involvement in the economy which may generate disincentives, retard flexibility, and work against the desired allocation of resources" (p.50) - "desired", presumably, because the efficient allocation of resources, according to neoclassical economics, is the presumptive product of the ideal market. However, despite thereby perhaps risking the appearance of being interventionist, the state must inevitably involve itself in *industrial* policy: "... the issue is not whether to form an industrial policy, for implicitly or explicitly, an industrial policy follows from the decisions governments make regarding tax policy, trade policy and the many factors that bear upon the efficient allocation of human, capital and natural resources.... Canada's industrial policies [should] be more attentive to enhancing the productivity and competitiveness of our economy. Industrial policies, in short, must be made more harmonious with market forces than past practice has made them. The implications of this conclusion suggest a fundamental realignment of industrial policy, both at the federal and at provincial levels" (pp.51-2). Government sets the context for industrial development, but should stay out of the process as

far as possible; it should merely "... encourage the process of adjustment to new competitive forces", making "a commitment to framework policies that encourage adaptation", and thus efficiency (Macdonald, 1985, Vol.II, pp.205-6). Accordingly, industrial regulation - since, if "... excessive or misdirected... [it] can constrain competition and restrict improvements in productivity" (ibid., p.209) - should be reduced correspondingly: particularly where it hinders innovation and cost minimization (reducing potential productivity), or creates undue delays and uncertainty for businesses (reducing potential competitiveness) (p.211). (An apparent confusion between competition (which is usually in the public interest) and competitiveness (which is in business's) should be noted here.)

So government regulation - itself a costly process and one, imposed as it is by central planners, that may take little account of the cost-minimizing principles that drive private production, thus hampering productive efficiency - should be reduced, particularly where its effects are not in the collective interest of society "... in safe products, a safe workplace, and a healthy environment" (p.214). In fact, in the light of the 'philosophical' orientation of the Commission's other conclusions, leading it to urge minimization of regulation as a first principle, the report's recommendation that environmental regulation should actually be *increased* seems somewhat anomalous - a tension reflected in the statement that "although many of our recommendations elsewhere in this Report call for reductions in government intervention, Commissioners believe that the environmental field is one in which greater government intervention will prove to be necessary" (p.527).

This seeming anomaly - the simultaneous prescription of less regulation, to serve the all-important goal of increased market adaptability, yet more for environmental purposes - may not be unconnected with the British Columbia Provincial government's omission of any

provision for the environment in its economic policies as set out in its Budget statements from 1983 to 1985, the same crucial period for salmon farming. These statements present a rather less coherent, or consistent, intellectual analysis than the Macdonald Report. In the wake of a particularly severe recession in B.C. in 1982 (MF, 1983, p.5), and an election victory in 1983, the Social Credit government took the opportunity to conduct major reforms of the provincial public sector: of the province's bureaucracy [2], and its social programs. It was to be a period of belt-tightening, or "restraint" (p.3). In tune with the Macdonald Commission's admonitions about the unchecked incremental growth of government over the preceding years (1985, Vol.I, p.47; above), the B.C. government had determined to apply the (economic) principles of marginalism to the public sector:

Governments everywhere have run up against the law of diminishing returns. The more expenditure grows the less each dollar adds in service to the public. It is time to reverse this process. It is time to strive for more with less. Productivity must become a central theme (MF, 1983, p.12).

This statement marks a continuation of the Restraint on Government Program set up in February 1982 (MF, 1984, p.2), prior to the Social Credit re-election. It also appears to owe something of its philosophy to planning-programming-budgeting, a system of government rationalization dating from the 1960's, "... devised to reform... incremental... budgeting practices...." Programs should be cost-effective, and budgets efficiently planned over several years (Culhane et al., 1987, p.6). Brooks traces the intellectual origins of such program evaluations (along with other forms of "rational policy analysis", like Cost-Benefit Analysis) to welfare economics, "... a branch of economics that studies the conditions under which the welfare of society can be maximized, within the constraints imposed by scarcity of resources" (1989, p.68). Given particularly constrained resources at the time (low, in 1982 even negative, growth (MF, 1983, p.5)), the fat must be trimmed from the public sector, making it "lean and efficient" (MF, 1984, p.17), and the economy freed from the "tangled regulatory web" that had begun to envelop it (MF, 1984, p.3). Also in conformity with the Macdonald Report, "essential services" of the welfare state would be maintained - but there were "... real limits to the range and volume of services" that could be provided (MF, 1984, p.2). Health care and unemployment insurance were considered "essential", the environment, judging by the lack of provision for it, apparently less so. Wherever possible, the private sector would be given "... the opportunity to take over functions and activities not appropriate to government" - privatization "... essentially mean[ing] less government and lower expenditures" - and though "in certain areas full privatization is neither possible nor desirable [, t]he government will, however, reduce staffing while drawing more heavily on services offered by the private sector where appropriate" (MF, 1983, pp.16-17).

Though spending would thus be drastically cut on government programs, especially ones providing the "less essential" social services (1984, p.6), there would be "... a policy of selective stimulation to help sustain employment and accelerate recovery" in the private sector, at the same time as "efforts to improve competitiveness" and to remove "barriers to innovation and higher productivity" there (p.3). The recovery would be 'market-driven': "The solution is at once very simple and very difficult: respond to the demands of the world marketplace and become more and more productive at what we do best" (ibid.).

The fragility of the slow recovery in 1983 was emphasized: unless there was restraint it "... could be very sluggish... falter or even collapse" (1983, p.6) - and the route to stability (and growth) seen in developing "... a strong and vibrant business community which can compete with the best" (1984, p.17). By March 1985, with recovery continuing (though still fragile, growth running at less than 2.5 percent (MF, 1985, pp.5-6)), "... a range of expenditure initiatives representing investments in the future of British Columbia's economy" could be made (ibid., p.6) - though *only* because of the success of the continuing restraint and efficiency program (p.7). Competitiveness, so important in an increasingly cut-throat international marketplace (p.2), could be enhanced by easing the tax burden on businesses (p.6); and funds would be provided to stimulate industrial development and diversification (such as the \$650 million under an Economic and Regional Development Agreement with the federal government (p.8)). Competitiveness demanded not only increased productivity, but also speedy development: "To compete successfully our industries must be able to respond and adapt quickly" (p.4); and aquaculture (particularly salmon farming), a new, developing, high-tech industry with high growth potential and an export market, appeared to fit the bill most opportunely:

Aquaculture has the clear potential to be a growth industry in British Columbia for the rest of this century. We are well behind such competing nations as Norway and Japan in farming the seas, but our natural advantages give us the chance to develop this sector quickly. British Columbia is ready to move into aquaculture in a serious way. The new exemptions will assist the industry and demonstrate that we mean business (p.10).

At much the same time a federally-appointed task force was conducting an evaluation of federal programs. Set up in 1984, the Task Force on Program Review brought the methodology of rational policy analysis - again in a form similar to the planning, programming, budgeting system - to bear on what it saw as the vast, irrational regulatory burden in the marine fisheries, the jurisdiction of the federal Department of Fisheries and Oceans. Reporting in May 1985, this unit of the "Nielsen Task Force" dependably condemned

bureaucratic incrementalism and set to applying economic efficiency criteria (roughly, the requirement that aggregate benefits should maximally exceed aggregate costs) to the DFO's regulatory program. Largely in conformity with the Macdonald Report it recommended a major reduction in government intervention, and instead a "... much greater reliance on industry self-regulation and on market solutions" in the commercial fishery (TFPR, 1985, p.274). Applying standard neoclassical economic conceptualizations - the idea of common property, or congestion, externalities (ibid., p.270), and rent dissipation (p.272) - the study team concluded that the *regulation* necessary to ensure conservation and prevent conflict should be rationalized: simplified, clarified, and reduced (p.273). Though existing *enforcement* of conservation measures was inadequate (p.281), the reduction in regulations "... should clearly have to be accompanied or encouraged by a corresponding decrease of federal resources assigned to the fisheries" (p.274) - fewer funds, presumably, not only for regulation, but for enforcement too. (Enforcement should apparently be made more efficient by increasing the degree of deterrence (p.282).)

These principles were applied to the commercial fishery as a whole [3], and, apparently, to salmon farming, aspects of which also fell under DFO's jurisdiction (see Chapter Five).

#### Ecological effects

Throughout much of the development of B.C. salmon farming, controversy has surrounded the general issue of its possible ecological effects. To some extent this is not surprising. In the science of ecology, as I said before, uncertainty, both theoretically and empirically, is pervasive, multi-faceted, and fundamentally significant. In ecological nature in general, as Holling puts it, "... however intensively and extensively data are collected, however much we know of how the system functions, the domain of our knowledge of specific ecological... systems is small when compared to that of our ignorance" (Holling, 1978, p.7). Ecology has been defined as "... the scientific study of the interactions between organisms and their environment" (Begon, Harper & Townsend, 1986, p.x), and in fact *interaction* is central to ecological systems. Interactions within 'the system' are usually complex, so that many of the effects of any change may be indirect, involving multiple causal linkages. The more profound the changes in and to the system, it can be assumed, the more complex are the effects. The indirectness of effects may be manifested in such forms as geographical displacement and time-lag: "events at one place can re-emerge as impacts at distant places.... Impacts are not necessarily immediate and gradual; they can appear abruptly some time after the event" (Holling, 1978, p.20). And in fact even small changes *can* have significant impacts [4]. For these reasons, 'linear' prediction - applying simple, known cause-and-effect relationships, or smooth extrapolation from past trends - is seldom fully accurate or adequate.

So even in situations where information (data on conditions, and functional knowledge) is good, it may be very difficult, or impossible, to *predict* many future ecological effects precisely, and equally hard to *understand* fully some effects that have been observed. These uncertainties are compounded when knowledge of conditions and system functions is in fact poor. That has been the position in B.C. salmon farming. Salmon farms are dispersed over large areas of the B.C. coast: the relevant environment is large and diverse. The geographic range of possible ecological effects is extensive, also, because of the aquatic medium in which salmon farming operates, which promotes interaction between organisms and their
surroundings: interactions between fish farms and wild salmon stocks may take place because of the highly migratory nature, at sea and in rivers, of anadromous salmonids; interactions between salmon farms and the marine ecosystem may occur through diffusion (of wastes, chemicals, etc.) between water inside and outside the net-pens. Not only is the relevant 'ecosystem' diverse and complex, but it has also been relatively little studied. Thus the first attempt at an inventory of biophysical conditions over parts of the coast relevant to salmon farming was only completed in 1987 (and only of those conditions relevant to the industry) [5]. Equally, many of the introductions necessitated by salmon farming have been novel products, or ones new to this environment - their likely effects there (the functional relationships) little studied or understood. In one case in particular [6], a significant possible effect of salmon farming has been observed, but its cause - the functional relationship determining it - is not known.

What can we conclude from this catalogue of uncertainties about possible ecological effects? In a few cases, we now have empirical proof that some ecological harm *has* been caused by salmon farm introductions [7]. But in the majority, we have only inconclusive evidence - not finally proven by experience - of possible damage that may have occurred, or may be yet to occur. The theoretical and practical uncertainty prevalent in salmon farming - the possibility of surprises and time-lags, and ignorance of conditions and relationships - suggests that *conclusive* evidence of harmful past and future effects may be hard to obtain. We must therefore judge the *inconclusive* evidence that we do have in order to make decisions and take actions in the meantime [8]. The Gillespie Inquiry certainly found that many of the risks implied by the existing, largley inconclusive evidence were 'real' and significant, and that has generally been the public consensus since. From a normative

perspective we can say that 'circumstantial' evidence at least should not have been ignored, especially early in the development when ignorance was greatest. Some corresponding 'insurance' against ecological harm, based on consideration of this evidence, could then have been expected. And we can say that search should have taken place, and should continue, in order to reduce our substantial ignorance about ecological effects. (See Chapter Five.)

I will now summarize and attempt to classify the most significant ecological potentials of B.C. salmon farming, those that might prompt significant government decision-making.

#### Genetic dilution

There is no doubt that farmed salmon escape from net-pens and can mix with wild stocks. Thus "it has been estimated that on average 15 percent of [Atlantic salmon [9]] held in fish farm cages escape accidentally" (NASCO, 1988, p.7); while surveys of rivers in southern Norway in 1987, for example, revealed that nearly half (23 out of 54) bore farmed salmon, and that more than 13 percent of the salmon sampled were of farmed origin (Lindgren, 1988, p.2). Equally there is little doubt that individual salmon rivers (Atlantic and Pacific) bear genetically distinct wild populations - sometimes more than one within the same river system (Egidius et al., 1988, pp.7-8). Such populations appear to have developed genetically based stock characteristics affecting, for example, return migration and resistance to disease (Maitland, 1989, pp.12-13). These are likely to be sophisticated adaptations to the relevant environment (ibid., p.20); and genetic variability within the population "... enables adaptation to differing environmental conditions and therefore assists its long term survival" (NASCO, 1988, p.2). Reared salmonids in rivers foreign to their genetic origins show poorer survival (adaptation) than wild ones in their natal rivers; and

artificial stocks may show reduced genetic variability through inbreeding (Maitland, 1989, p.14). The problem of gene transfer from farmed salmon selected for artificial living conditions and propagated from diverse gene pools seems to be greater than transfer of reduced genetic variability (Egidius et al., 1988, p.10): "... escapees which reproduce in rivers chosen [at] random [10] will always decrease the differentiations between the wild salmon populations" (ibid., p.8).

The possibility of reduced adaptation of wild stocks through interbreeding with farmed ones has some subtle ramifications. Thus hybrids could show improved short-term adaptation, leading to their out-competing the remaining natives before declining themselves (Egidius et al., 1988, p.9). (A large-scale transfer of chum salmon to the Naiba River in the USSR appears to have had this effect, driving a population of 650,000 native spawners in 1968 to virtual extinction, along with the hybrids, by 1985 (Maitland, 1989, p.16).) Also, escaped fish with foreign genetic disease resistances could introduce those diseases to wild stocks without the resistance (Egidius et al., 1988, p.9); and one hypothesis for the virulence of *Gyrodactylus* in Norway (described below) is that, though the parasite was already endemic in the environment, the infestation occurred because resistance of wild stocks was lowered through interbreeding with reared fish (Maitland, 1989, p.21).

In all, there clearly is uncertainty about the potential effects of intra-specific hybridization, so that several studies call urgently for further research on the question (eg. NASCO, 1988, p.16). The risk (which as suggested above, is not fully separable from the disease question), were interbreeding to occur, is taken seriously in Norway, where some authorities consider that escapees represent a greater threat to natural salmonid genetic

resources even than acid rain (ibid., p.14) [11]; while in Scotland, it has been recommended that "rather than risking [genetic] damage to wild stocks through escapes and indiscriminate releases of farmed salmon it would be sensible to adopt a more cautious approach" (Maitland, 1989, p.22). Even so, whether farmed salmon *do* successfully (inter-)breed in the wild is still unknown, though as "... Atlantic salmon is a species native to Norway it is likely that [farmed] salmon can yield viable offspring...", and spawned-out farmed rainbow trout (non-native) (Egidius et al., 1988, p.3) and salmon kelts (Meggs, 1988, p.6) have been observed there. Thus, logic points to the possibility of some breeding success between farmed and wild salmonids of the same species [12] - but difficulty of observation in the aquatic medium makes it hard to confirm (or deny) the possibility empirically.

Though there are, of course, major genetic similarities between Pacific and Atlantic salmon, the risk of gene transfer in B.C. is somewhat different from that in Norway and Scotland. Maitland recognizes that natural straying and mixing of stocks by man have occurred in Scotland, but concludes that basic genetic integrity (fitness) has been preserved because the numbers introduced were minor compared to the existing wild stocks. Indeed, "it is clear... that the numbers of eggs or fish involved in translocations or stocking were of one, two or possibly three orders of magnitude less than the hundreds of thousands or even millions which are feasible today" (1989, p.19). He thus questions the appropriateness for genetic integrity not only of salmon farming, but also of hatchery enhancement - a technique that has been judged largely successful in B.C. for many years. Not wishing to get involved in a debate over the genetic effects of hatcheries on wild stocks, I can, however, distinguish salmon farming in B.C. from that question by pointing out that genetic differences between

farmed escapees and the wild stocks they may encounter are likely (progressively, as farmed stocks are artificially selected) to be greater than the differences between (the more natural) enhanced stocks and the wild salmon *they* may breed with. Also, though escapees are at present unlikely to outnumber the large Pacific salmon stocks in large rivers, and thus significantly dilute the gene pool, they might do so in small streams (or in the presence of small individual stocks, such as steelhead) in B.C.:

Low numbers of spawners (effective population size) will always increase genetic drift, decrease heterozygosity and consequently increase the risk of loss of genes (Egidius et al., 1988, p.9).

Perhaps more than anything, the genetic dilution question is illustrative of the complexity of ecological systems, the poverty of our knowledge of them (especially in this case, where the salmon's migratory environment is so extensive and in practice precludes much observation), and the necessity somehow to keep anticipating and adapting to the unpredictable, which will inevitably assert itself: thus the widespread call for more research on these interactions (eg. Sattaur, 1989, p.58).

## Disease transfer

Less controversial as a threat to wild salmon stocks, though still in many ways uncertain, is the possibility of disease transfer from farmed fish. (The risk is in fact mutual (eg. Lindgren, 1988, p.3).) Thus "the ICES ad hoc Study Group on Environmental Impact of Mariculture believe[s] that the importation of exotic species or disease organisms is the greatest environmental risk associated with mariculture because the consequences may be widespread and irreversible" (NASCO, 1988, p.2). The most obvious example of damage to wild stocks from an organism introduced (or rendered pathogenic) through man's activities is provided by the monogenean fluke *Gyrodactylus salaris*, which by 1988 had infested 32 rivers in Norway, causing an estimated loss of 250-500 tonnes of wild salmon, for example, in 1984 (Egidius et al., 1988, p.4). The damage has been major and well-documented; but what is less certain is the exact origin of the parasite. "The fluke is believed to have been imported with smolts for farming from Sweden to Norway in the early seventies", according to a Norwegian report - thus connecting its introduction with salmon farming (Egidius et al., 1988, p.7). The means of spread from the Norwegian hatcheries seems to have been more complex: the "...Directorate for Nature Management... found that all but three of [the infected] rivers had been stocked with fish from hatcheries infested with the parasite. One of the [remaining] three may have received fish from Sweden, while the other two may have been infected by anglers with contaminated equipment or by fish farmers transporting infested salmon smolts from hatcheries to fish farms and changing their water in the rivers" (Sattaur, 1989, p.56). (I have quoted a further hypothesis for the pathogenic origins of the parasite above.)

From this evidence it can only be safely asserted that salmon farming substantially increases the *risk* of introducing pathogens, through the large increase in salmonid import and transfer activities that results from farming; wild stocks may often not be genetically resistant to such exotic organisms brought in with stock for farming. There is uncertainty about what potential pathogens wild stocks *are* resistant to (indeed whether the organisms are truly exotic), and about how such pathogens may be transferred to salmonids: for example, "the chance for a pelagic-living larva [the sea louse] to encounter its host in the... sea does not seem very large", and yet infestation by it (of farmed stocks) is a major

problem in Europe (Egidius et al., 1988, p.5). In March 1989 a virus, viral hemorrhadic septicemia (VHS), was isolated at two hatcheries in Puget Sound off Washington state, first showing up in returning adult coho and Chinook salmon (New York Times, 7/3/89). Though apparently not fatal to salmon, this disease organism can kill the important anadromous steelhead trout (ibid.), which exhibits a similar migratory pattern and may mix with salmon. The isolation was the first finding of the virus in North America, though it is widespread in Europe - the implication being that it was introduced from there (ibid.), though there has been no trace of it in Atlantic salmon imported to the West Coast for salmon farming (MAF 25-1, 1990, p.5), and it could conceivably have been indigenous but only recently tested for. Its origins are frankly admitted to be unknown (NWPS, 1989, p.44). Comparably, in 1985, the exotic disease furunculosis, present in salmon farm smolts, was transmitted from Scotland to Norwegian farms (Meggs, 1988, p.3), but since it has been found in a Norwegian river, the Numedals-lagen, without apparently affecting salmon catches there (Lindgren, 1988, p.3) it may not be harmful to wild salmon (Egidius et al., 1988, p.7). Infectious Pancreatic Necrosis has been observed to pass from farmed to wild stocks but not to be significantly harmful (NASCO, 1988, p.10); and the possible effects on wild stocks of some other fish farm introductions, such as the bacterium Yersinia ruckeri (enteric redmouth) in Norway, are unknown (Egidius et al., 1988, p.6).

Evidence of the effects on wild fish, which obviously may die at sea or in rivers before any disease is observable, is not surprisingly very sparse (cp. NASCO, 1988, p.10). But despite the necessarily poor evidence and the indirectness of causation of harmful effects that *have* been observed, the weight of circumstantial evidence and the catastrophic consequences should empirical confirmation occur (ie. if the large B.C. stocks were seriously infected on the lines of the *Gyrodactylus* outbreak) point to an extremely cautious approach to salmonid imports and transfers. Thus the 1988 "Federal and Provincial Regulations Regarding the Movement of Fish" apparently "... stem from ... governments' concern for the potentially disastrous effects (ecological and disease related) resulting from the movement of fish..." (MEP, 1988, p.2). Similar concern is expressed in the DFO's 1987 aquaculture guidelines:

The transport of live seawater-reared salmonids, their eggs or milt must be approved by the Transplant Committee. A copy of the Committee's Transplant permit must accompany each shipment. No fish shall be allowed to escape during transport and no dumping of dead fish or water en route is permitted. All dead fish must be disposed of in an approved manner (DFO, 1987, p.6).

## Effects on the marine environment

Uncertainty is prevalent in this case also, and it is not confined to ignorance of the precise effects on 'the environment' of introductions by man - but has also applied to just what those introductions (fish farm residues), and their destinations, were and are.

A variety of chemicals, sometimes new formulations, have been introduced to the marine environment by salmon farms before controlled ecological testing of them has taken place. "Pesticides which are used... include antifoulants, fungicides, parasiticides and wood preservatives. The extent of their use by this industry has not been documented in B.C.. Marine environmental effects, including fate, persistence and impacts on non-target organisms, are poorly understood. None of these substances are registered yet under the federal *Pest Control Products Act* or provincial *Veterinarian Act* for use in the marine environment for fish farming purposes" (ME, 1990, p.20).

Also, it must always have been obvious that large quantities of fish feed (and correspondingly, faeces) were entering the marine environment [13], and B.C. government research pre-dating the 1986 Gillespie Report identified the major environmental effect of farms merely as "... alteration of the local seabed due to the build up of organic waste from fish pens" (Gillespie, 1986, p.36; cp. p.18). Ironically, since about 1988 "... there has been a general trend among regulatory agencies to view direct sedimentation impacts on the environment as a lesser problem" (MAF 24, 1988, p.6) than possible diffusion effects identified after the Gillespie Report.

Prior to the report it was apparently assumed that any introductions to the water column itself (as opposed to whatever was deposited on the sea bed) would be rendered harmless through dilution - this, according the the provincial government, being the solution to any potential pollution by antibiotics, for example (Gillespie, 1986, p.19). It is now recognized that "the most significant characteristics of fish farm wastes *as they affect water quality* are nitrogen and phosphorous compounds, oxygen consumption and suspended solids" (NASCO, 1988, p.12; cf. MAF 31, 1990, p.9; italics added), and that "poorly sited and operated farms can... cause significant, localized environmental degradation" (MAF 24, 1988, p.1), so that in the Sechelt Inlet system, for instance, where there is a high concentration of farms, there is "...potential for increasing [water quality] effects of farming as production increases" (ibid., p.8). Largely the result of research initiated under recommendation 4.5.1 of the Gillespie Inquiry (MAF 24, 1988, p.10), the present state of knowledge of the destination and effects in B.C. of fish feed and faeces can be summarized as follows:

Nutrient enrichment and sedimentation from uneaten feed and fish wastes are [a]

waste management concern. Marine fish farm operations generate significant amounts of waste feed and fish faeces. Depending on site conditions (ie. depth, currents, bottom profile), these organic wastes may accumulate on the seafloor and contribute to local plankton blooms, local biochemical oxygen demand, changes in sediment chemistry (including hydrogen sulfide and methane production), reduced water quality, and smothering of local benthic fauna and flora. This may, in turn, affect farmed fish and other sensitive resources and uses (ME, 1990, p.14).

Two chemicals used in salmon farming, in particular, have received much publicity, and some of their toxic effects are now fairly well-known. Tributyltin (TBT), a paint constituent pesticide used to reduce pen net-fouling, is highly toxic (to fish and shellfish, apparently even in concentrations as low as five parts per trillion) and was found in marketed salmon for the first time in Washington state in November 1986 (<u>The Fisherman</u>, 11/'86). (A December1986 Washington study, noting the toxicity of TBT, recommended it be banned from Puget Sound salmon farms, where in fact it was not known to be used at the time (SAIC, 1986, p.32).) Studies of a B.C. fish farm site subsequently detected the compound in salmon and oyster tissue, and "morphological changes in oysters and some endemic fauna were also noted" (MAF 24, 1988, p.3). Following a B.C. Salmon Farmers Association ban in early 1987, "... 5 or fewer farms [of the original 35 using it in B.C.] still had TBT-coated nets in the water" by the fall (ibid., p.4), with some still persisting in December 1987 (SCFO, 1988, p.28).

Of more recent concern has been the potential [14] treatment of sea-lice infestations of farmed salmon with a type of dichlorvos (trade name Nuvan), which is "highly toxic" to humans, as well as salmon if they are exposed for too long, and can affect "other organisms, particularly crustacea..." (MAF 29, 1990, p.1). "Care should be taken to minimize dichlorvos contact with non-target species", according to the B.C. government, though "other studies have shown that the effects of Nuvan on [such] species are minimal and are restricted to the immediate farm site" (ibid.). By contrast, a British Institute asserts that dichlorvos "... has posed a serious threat to other marine life [non-target species] and has been linked to a sudden increase in the incidence of cataracts among wild fish" (IFM, 1989, p.12). Despite the uncertainty, the B.C. government recommends careful use of the chemical, and efforts to develop an alternative rapidly, but no ban (MAF 29, 1990, pp.1-2).

A further area of ignorance (and dispute), already mentioned, is the fate and effect of antibiotics. Because diseases, such as Bacterial Kidney Disease, continue to cause huge losses of farmed salmon, large quantities of antibiotics are used to combat them (in Norway, apparently, more than for all agricultural and medical uses combined (Lindgren, 1988, p.4)). In spite of assumptions made about dilution (above) prior to the Gillespie Inquiry, the provincial government now admits some uncertainty, not only about the human health implications of possibly selecting drug-resistant pathogens, but also about "... the fate of antibiotics used on farms and their effects on adjacent biota. There is little literature in this area. Much of what is published pertains to the commonly used water soluble therapeutant oxytetracycline. There is very little information on lipid soluble therapeutants" (MAF 24, 1988, p.5). Even so, a 1986 U.S. report had warned that "these substances should be used as sparingly as possible.... Antibiotics should not be used prophylactically on a long-term basis" (SAIC, 1986, p.32). Equally, "...prolonged drug use may result in drug-resistant bacteria in some systems" (MAF 25, 1988, p.5), and such bacteria could conceivably spread resistance to other bacterial communities, with implications for public health (Austin, 1988).

Possible long-term environmental effects generally are now of major concern in

Norway (Meggs, 1988, p.7), which has a longer salmon farming history than British Columbia. "It is too early in the development of the industry in this Province [B.C.] to predict whether or not local or cumulative environmental impacts might occur at some locations. Comprehensive knowledge is lacking on the future growth and direction of the industry and on complex coastal conditions" (ME, 1990, p.4). One Atlantic report notes that "... vitamin and trace materials may have subtle effects and there is evidence that the toxicity of *Gyrodinium aureolum* is enhanced by biotin, a constituent of fish farm wastes" (NASCO, 1988, p.12). The provincial government, in a summary of environmental assessment initiatives, also notes compound effects:

The effect of aquaculture structures on water circulation can be dramatic. Creation of small scale circulation patterns can lead to localized problems with water quality or changes in the distribution of sediments. Water circulation probably modifies most of the effects previously discussed in this paper (MAF 24, 1988, p.6).

Similarly, "there is increasing evidence that the behaviour of wild fish may be modified by the presence of cages" (NASCO, 1988, p.13). Indeed, there is a host of other possible composite problems, or secondary effects of the main introductions, which have come to light over time: possible disease transfer from 'morts' (farmed salmon mortalities) improperly disposed of (ME, 1990, p.10), damage from dredging accumulated sediments (ibid., p.15), which is necessary in poor sites (NWPS, 1989, p.32), and dangers from transporting toxic materials (ME, 1990, p.19) - to name a few. It seems likely that other such hazards will continue to reveal themselves, as they have in Norway, which (partly) as a result now takes extremely stringent environmental precautions - declaring large areas of its coast "security zones" free of farming activity (Meggs, 1988, p.3).

(See Appendix III for a summary of potential ecological impacts on the marine environment.)

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# **Notes**

[1] This passage in the 1988 Ombudsman's report illustrates the continuing controversy over possible costs and benefits of salmon farming: "As the industry attempts to advance its interests in establishing itself as a viable and important element of the British Columbia economy, it must at the same time fight a continual battle with those who believe with similar sincerity that the widespread growth of the industry will produce long term costs for the province far in excess of any benefits conferred" (Owen, 1988, p.5).

[2] Encompassing, also, individuals less directly 'employed' by the province, such as teachers (MF, 1983, p.62).

[3] As is substantially confirmed by a 1988 report (OPRA, 1988, pp.15-17).

[4] This tendency has also been recognized in economic systems: "There is increasing questioning, after the development of chaos theory in mathematics, about whether economic systems, given their complexity and the possibility that small changes in some variables will produce enormous changes in the overall system, [are] inherently chaotic and [do] not lend [themselves] to dependable forecasts" (Globe & Mail, 2/1/'90).

[5] This study (Ricker, 1989) had to use "... somewhat inferential appraisals..., particularly for the Northern Project Area..." (p.80). "The most detailed knowledge is for those areas lying on the perimeter of the Strait of Georgia and in Howe Sound. Farther to the north where human population is sparse, scientific data are much more limited..., if not missing..." (p.24).

[6] The 'exotic' disease VHS in wild salmon stocks in Puget Sound: see below.

[7] Such as TBT: see below.

[8] Some 'inconclusive' evidence of likely effects in B.C. is provided by the comparable industry in Norway, for example. The Norwegian salmon farming industry was already established as the main B.C. development began, and in a somewhat similar environment, but there were important differences, such as the relative fragility of Norwegian wild salmon stocks. Observations from the Norwegian industry could have been used for ecological decision-making in B.C., but would then have been based on judgments of whether the relevant facts were sufficiently similar in the crucial respects - a question of "informed scientific opinion" (Shah, 1964, p.48), rather than definitive proof. I will in fact draw extensively on the Norwegian experience below, at all times bearing in mind the technological and environmental similarities with, and differences from, the B.C. situation.

[9] The technology of salmon farming in the Pacific is not, for the present purposes, significantly different from that used in the Atlantic - from which, in fact, much of the Pacific apparatus derived.

[10] Escaped mature farmed salmon have been shown to enter available rivers at random when ready to spawn (NASCO, 1988, p.7).

[11] "In Norway, where salmon farming has been established for some 20 years, stock [genetic] selection has progressed to the extent that the genetic problem is now regarded as the greatest potential threat facing wild salmon" (Maitland, 1989, p.23).

[12] Coho and Chinook salmon, and steelhead (rainbow) trout, are the species native to the Pacific Northwest farmed in B.C.. Farmed fish of these species *could* interbreed with the wild stocks in B.C..

[13] By way of illustration, today's ME Waste Permits apply only to farms using over 630 tonnes of dry feed per year (ME, 1990, p.7); farms using less are considered relatively small.

[14] The present use of Nuvan in B.C., where it is unregistered, is unknown but not inconceivable. The possibility of its future, legalized use in B.C. has not been excluded by government (AI Castledine, MAF, pers. comm., 23/1/91).

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## CHAPTER FOUR

## "THE MARKET PULL APPROACH TO DEVELOPMENT"

#### Indications of laissez faire in salmon farming policy

I previously suggested both that there is evidence that government salmon farming policy has been, in some imprecise sense, a laissez faire one, and that any such policy has seemingly been lacking in logical consistency - hence the chaotic appearance remarked upon at the very beginning (in Chapter One). It is time now to make good those claims. This section is also intended, as proposed in the research aims described in the same chapter, to indicate that salmon farming policy contained elements that are distinctive features of the neoconservative model, preparatory to analyzing that theory.

Laissez faire, by definition, entails a presumption that government should be minimized. This could mean brought to the minimum level at present possible, or the minimum level conceivable. The first meaning is the pragmatic version of laissez faire which, I submit, characterizes salmon farming policy - and the second is the idealized version, corresponding to neoconservative theory. But both versions share the same presumption against government, and for the same reasons: the unencumbered private market is efficient, and central planning is malignant. Central planning is *in* efficient, because it is rationalist; and corrupt, because it depends on the discretion of government planners, invariably favouring vested interests [1]. Even under the pragmatic version of laissez faire, then, there is a presumption against planning, which should only be called upon as a last resort.

Unfortunately for this point of view, extensive planning of one kind or another is a

reality in modern Western states:

It is not necessary to argue that the interpenetration of public and corporate planning in the market economy or that public planning and programming in the political economy [public sector] are desirable. It suffices that they exist and their massive extension is not to be avoided. The question is not whether, but how, and for whom.... These questions will not be of the order of "shall we have a free market or shall we have planning?" We have and will continue to have a market economy co-existent with a political economy, and there will be planning within and in respect to each (Solo, 1975, p.105).

This uncomfortable fact and, arguably, modern-day necessity may not sit well with laissez faire, but it is unavoidable. So we should not be surprised at evidence of *some* planning for salmon farming, even assuming its development was characterized by laissez faire. But if that label is to stick, there should at least be signs of reluctance about, or tension in, any such planning. And indeed, the only concrete expression we have to help identify general government policy towards salmon farming, the "market-pull approach to development" (ITFA 1984, p.5 [2]), intimates just such a tension between autonomous market and deliberate plan. At this point it is worth summarizing the history of planning in salmon farming as a whole to examine these points more closely.

A scheme involving the identification of high priority areas for B.C. mariculture had been offered to the ME Marine Resources Branch by the University of British Columbia (UBC) in November 1982 (Valiela, 1982), when the salmon farming industry was still in its infancy. The proposed system - involving the formulation of management goals, identification of present and possible future conditions relating to them, and, based on the application of that information to a particular region or area, calculation (using a ranking formula) of the best locations for encouragement of mariculture (ibid., p.36) - could fairly be described as rationalist; in fact the format conforms guite closely to the archetypal four-step process for rational decision-making described in Simon's <u>Administrative</u> <u>Behavior</u> (1947, p.67) [3]. Despite progressively paring the information necessary to make the designations, the system calls for fairly extensive information-gathering, and confident predictions, about the complete relevant range of possible physical and social conditions (such as habitat types, productivity potentials, economic development needs, and potentially conflicting uses (Valiela, 1982, p.20)); and, it seems, for considerable agency discretion (in defining some 'sociological benefits', for example (p.11)). The study also concludes that a unified management plan for the designated areas would lead to more effective and efficient operation of the existing mariculture referral process (McPhee, 1982, p.8); and, citing with approval draft legislation in Nova Scotia which, amongst other things, prescribes the collection of pollution baseline data, suggests that at some time in the future a new statute may be justified to unify mariculture administration (ibid., p.30).

Even earlier there had been calls for government to "strategize" for the mariculture industry as a whole, formulating development plans which should include:

1. A definition of [lead agency] goals and objectives in terms of effects on provincial income; government revenues...; numbers of jobs;... regional development and resource conservation.

2. Specific policies which will be implemented to achieve the goals of the plan. They should state how the plan will be implemented through the use of regulations, subsidies, and investment in research, development and extension activities.

3. Specific procedures for strategizing in the face of uncertainty including arrangements for revising the plan in response to changing demand and supply conditions, and the development of new knowledge and technology (Dorcey, 1979, p.71-72).

Both the specific UBC planning proposal, and the general approach to unified development planning (which might include new legislation) for mariculture expounded in this quotation, appear to have been rejected by the federal and provincial governments,

which by 1982 were immersed in the problems of deep recession in their economies, prompting the B.C. government to initiate formally its administrative restraint program. Thus in 1984, the federal Industry Task Force on Aquaculture, in producing its own so-called 'aquaculture development plan for Canada', complained of the continuing "... absence of a national aquaculture policy" and noted that "countries that have succeeded in developing aquacultural production... have clearly defined policies" (ITFA, 1984, p.14). The Task Force recommended "the passage of enabling legislation" at the federal level "...to reflect the national perspective on aquaculture", and at the provincial level to emulate the 1983 Nova Scotia "Act respecting the Encouragement and Regulation of Aguaculture" (ibid., p.16). The 1985 Statement on aquaculture by the Science Council of Canada, based on the Task Force report, reiterated the need for enabling legislation (SCC, 1985, p.23); but suggested that the Task Force report had gone some way towards formulating "a National Aquaculture Policy and Development Plan" for government (ibid., p.7). Even so, by 1988 the Report of the Standing Committee on Fisheries and Oceans could still recommend setting up a national committee "... to develop a comprehensive national aquaculture development plan" (SCFO, 1988, p.55), and "the introduction of a National Aquaculture Act... for the development of a consolidated and comprehensive body of federal regulation" (or the consolidation and improvement of existing legislation) (ibid., p.56).

A similar pattern is apparent at the provincial level. The 1986 report of the Gillespie "Inquiry into Finfish Aquaculture in British Columbia" found "the lack of a clear, comprehensive and integrated policy on aquaculture" self-evident (Gillespie, 1986, p.9), and concluded that "the lack of a strong provincial statement is viewed as detrimental to orderly and efficient growth of the [salmon farming] industry.... It is... viewed as necessary to ensure that environmental, land use, social and economic factors are identified as critical components of growth and regulation of the industry" (ibid., p.28). Two years later, the B.C. Ombudsman's report on "Aquaculture and the Administration of Coastal Resources in British Columbia" observed that "both the fish farmer and the coastal resident or resource user find that... there is little in the way of regulations, and virtually no statute created to deal directly with the aquaculture industry" (Owen, 1988, p.5). The report recommended "... the enactment of a separate Aquaculture Act... which gives clear, coordinated and express authority in this area", that "... the legal requirements [for tenure] should have a published statutory foundation", and that under the referral system "... written reasons should be provided by the appropriate ministry... to explain or justify decisions made or actions taken" (pp.96-98). It also advocated "a framework for integrated management of resources" of the B.C. coastal zone as a whole, emphasizing community plans "... produced in conformity with provincial goals and objectives"; and recommended that "a comprehensive set of priorities... be produced... though broad public participation. From these can be produced specific goals and objectives, which can then be translated into specific management plans..." (pp.99-100).

This short history of planning relating to salmon farming [4] bears out the points made earlier. There is enough inferential evidence, particularly, to support the claim that overall government policy towards salmon farming was a laissez faire one. There *had* been some actual, prescriptive planning, admittedly - primarily the non-governmental industry task-force's document [5], setting out the so-called "market pull approach to development", which was intended to be "... a first step toward preparing coherent national policies and a development plan for Canada" (ITFA, 1984, p.5). No subsequent step, though, was

apparently ever taken: as late as 1988 both the Standing Committee on Fisheries and Oceans and the B.C. Ombudsman could still complain about the absence of a comprehensive, unified development plan at either the federal or the Provincial level. Indeed, the evidence presented above - aside from the task force report and the Science Council statement based on it, though they do not present a serious counter-argument either - indicates, first, that comprehensive planning proposals and methods were available, and second, that none were followed up, the inference being that the idea of comprehensive planning was actually rejected. This apparent antipathy toward detailed planning is in line with neoconservative economic theory, as I shall explain more fully below: the more comprehensive - and thus rationalistic [6] - the planning, the more neoconservative enmity it incurs. In this sense the 'philosophy', or basic intent, behind salmon farming policy appears to have conformed with neoconservative theory, as what I called 'the idealized version of laissez faire' - even though actual, pragmatic policy actions exhibit departures from that ideal. So, for example, what might appear from its title to be a belated comprehensive planning document, the first so-called "Aquaculture Industry Development Strategy", produced by MAF in 1988 - while taking note of the "... need for government involvement to provide incentives", and of the need for government regulation, "... due to legitimate concerns about natural resource management, environmental quality and human health" (Fralick, 1988, pp.11-12) - again emphasized that "development of the aquaculture sector will be industry driven through the profit motive" (ibid., p.11). Not only is the "Strategy" not - nor is it intended to be [7] a detailed, unified plan for all aspects of subsequent salmon farming development, but the cited government involvement, compelled in part by the Gillespie Inquiry, is clearly subordinated to the industry-, or market-driven, laissez faire approach (cf. p.11).

So the realities of government intervention, and even planning, may intrude, but the basic approach - favouring 'the market' at the expense of government - remains the same. Thus overall government salmon farming policy, it seems - inarticulate and seemingly chaotic as it has been - has also been, over the course of development, in principle a laissez faire one. It is therefore appropriate now to look at some of the principles of laissez faire.

# The neoconservative model

Probably the most articulate proponent of the neoconservative approach (despite all

the publicity given to Milton Friedman) is the Austrian Friedrich von Hayek. A thumb-nail

sketch of the relevant aspects of his integrated theoretical work will be useful here.

Hayek's most basic theoretical assumptions are the fundamental changeability of social phenomena, their complexity and interrelatedness, and the limited nature of the human mind faced with this complexity:

If man is not to do more harm than good in his efforts to improve the social order, he will have to learn that in this, as in all other fields where essential complexity of an organized kind prevails, he cannot acquire the full knowledge which would make mastery of the events possible (quoted in Nishiyama & Leube, 1984, p.276)

Any 'system' (not perhaps a term Hayek would use on its own, but it conveys the

approximate meaning if not viewed as a rigid, bounded 'whole')

... is always the result of *interactions* among its constituent factors... [which]... do not remain constant but change in character, behavior, value and so on to reflect the effects of the interactions among them. That is, they *vary* as they interact (directly and indirectly) with each other. Neither the *emergent* results of the interactions among constituent factors [the varying 'system'] nor the *variations* of those factors can ever be analyzed either in terms of a whole alone or of the constituent units. [Hayek's m]ethodological individualism fills the need for a dynamic type of analytical method of socio-human phenomena (ibid., p.lvi).

His is a profoundly anti-determinist view of social phenomena. Hayek asserts that the methods of the deterministic 'hard' sciences, such as physics - by using which we can predict and control certain aspects of the future - are inapplicable to social phenomena:

The chief point that we must remember is that the great and rapid advance of the physical sciences took place in fields where it proved that explanation and prediction could be based on laws which accounted for the observed phenomena as functions of comparatively few variables.... This may even be the ultimate reason why we single out these realms as 'physical' in contrast to those more highly organized structures which I have... called essentially complex phenomena. There is no reason why the position must be the same in the latter as in the former fields.... A theory of essentially complex phenomena must refer to a large number of particular facts; and to derive a prediction from it, or to test it, we have to ascertain all these particular facts.... The real difficulty, to the solution of which science has little to contribute... consists in the ascertainment of the particular facts (Nishiyama & Leube, 1984, pp.274-5).

The unique knowledge derived from individual experience of the particular circumstances of time and place can only be known by separate individuals, not by science, which "... aims at the discovery of what are sometimes called 'general facts', which are regularities of events" (ibid., p.256); there is thus "... a body of very important but unorganized knowledge which cannot possibly be called scientific in the sense of knowledge of general rules" (p.214): in all there is "a sum of facts which in their totality cannot be known to the scientific observer, or to any other single brain" (p.270). Many of the most important *economic* data - the individual plans of consumers and producers - fall into this category. Even the most authoritarian and organized state (the 'single controlling mind') could never gather all this unique information and use it to design a rational economic system; and the costs of even attempting to do so would far outweigh the benefits.

Because of the economic importance of the 'particular facts', and of unpredictable

change, rationalist centralized planning, at its most extreme "direction of the whole economic system according to one unified plan" (p.213), is not merely inefficient incurring huge search costs - but ineffective at meeting the economic goal of appropriate resource allocation: it must ignore the unique, perhaps transitory information known only to individuals, being able to handle only relatively homogeneous, generalizable data that is not sensitive to the changing requirements of consumers and producers. Correspondingly, since

... the economic problem of society is mainly one of rapid adaptation to changes in the particular circumstances of time and place, it [follows] that the ultimate decisions must be left to the people who are familiar with these circumstances, who know directly of the relevant changes and of the resources immediately available to meet them. We cannot expect that this problem will be solved by first communicating all this knowledge to a central board which, after integrating all knowledge, issues its orders. We must solve it by some form of decentralization. But this solves only part of our problem. We need decentralization because only thus can we ensure that the knowledge of the particular circumstances of time and place will be promptly used. But the "man on the spot" cannot decide solely on the basis of his limited but intimate knowledge of the facts of his immediate surroundings. There still remains the problem of communicating to him such further information as he needs to fit his decisions into the whole pattern of changes of the larger economic system (p.217).

This is done by the price system, whose "real function" is as an efficient mechanism for

communicating information (p.219):

Fundamentally, in a system in which the knowledge of the relevant facts is dispersed among many people, prices can act to co-ordinate the separate actions of different people.... The whole acts as one market, not because any of its members survey the whole field, but because their limited individual fields of vision sufficiently overlap so that through many intermediaries the relevant information is communicated to all.... The most significant fact about this system is the economy of knowledge with which it operates, or how little the individual participants need to know in order to be able to take the right action. In abbreviated form, by a kind of symbol [prices], only the most essential information is passed on and only to those concerned (pp.218-19). Given "the unavoidable imperfection of man's knowledge and the consequent need for a process by which [economic] knowledge is constantly communicated and acquired" (p.223), the price system, and the market mechanism of which it is an integral part, are admirably well-fitted, though not consciously designed; they are, according to Hayek, the products of social evolution: "We have developed... practices and institutions [such as the market mechanism] by building upon habits and institutions which have proved successful in their own sphere and which have in turn become the foundation of the civilization we have built up" (p.221).

Competition is the driving force of the market mechanism - competition between producers for sales to consumers, and thus for profits. The motivation for competition is self-interest, the societal role of which is asserted in this famous passage from Adam Smith's <u>Wealth of Nations</u> (1776):

An individual generally neither intends to promote the public interest nor knows by how much he is promoting it.... By directing industry in such a manner as its product may be of greatest value, he intends only his own personal gain, and he is in this aim... led as if by an "invisible hand" to promote an end which was no part of his intention.

Market transactions motivated by self-interest can promote social welfare, simply because if a private exchange is voluntary, it will presumably not take place unless both parties believe they can benefit from it (Brander, 1988, p.23). The market mechanism, on this simple model, thus realizes mutual benefits for producers and consumers - the "mutual adjustment of individual plans" (Nishiyama & Leube, 1984, p.259), or best possible overall fulfilment of their respective requirements - thereby balancing constrained supply and expansive demand, without any conscious overall design. Competition directs producers to discover new means - to be put to the proof in the market - of satisfying consumers' insatiable and ever-changing requirements:

What [Hayek]... tried to explain... was that we all start from a position of relative ignorance and that we can only hope to discover available opportunities and co-ordinate our activities in and through the market process. Competition is not a battle between producers; it is first and foremost a *discovery procedure*. The economy is never in perfect equilibrium: there are always gaps to be filled by alert, profit-seeking entrepreneurs. Economic progress can, in other words, never become wholly automatic: invention can never become a routine. The would-be planners *assume* what has to be *attained*, namely the co-ordination process or dovetailing of individual plans....

... the trouble with competitions is not that somebody wins them, but that the state stops them, or at least rigs the rules.... Competition is a continuous, never-ending process, not for winning or losing, but rather for *selecting* winners and losers, or better still for providing people with information about *where* they are likely to win or lose (Gissurarson, 1984, pp.11-12).

The natural selection metaphor here is of course intentional. Natural selection, according to

Darwinian theory, operates through trial and error, adaptation to the circumstances of a

constantly changing environment being accomplished, though never perfectly, by nature's

genetic 'experiments', the appropriateness of which is tested according to the criterion of

survival. The necessity of discovering the contingencies and adapting to the changes of the

dynamic *economic* environment is not even considered by deterministic

... economic theory... [which] starts from the assumption of a 'given' supply of scarce goods. But which goods are scarce goods, or which things are goods, and how scarce or valuable they are - these are precisely the things which competition has to discover.... ... If anyone really knew all about what economic theory calls the *data*, competition would indeed be a very wasteful method of securing adjustment to these facts (Nishiyama & Leube, 1984, pp.255-57).

Economic trial and error enables discovery of the changing, unpredictable requirements of the economic system, but also produces (at least temporary) economic winners and losers; it "... necessarily involves the relative, and perhaps even the absolute, share of some having

to be reduced, although they are in no way responsible for that reduction." However, "not only continuous increase, but in certain circumstances even mere maintenance of the existing level of incomes, depends on adaptation to unforeseen changes" (ibid., p.261). In fact the principal importance of the competitive mechanism is that it provides the maximum opportunities for economic growth: "... it [means] that of the combination of commodities that is in fact produced, as much will be produced as we know to bring about by any known method" (p.260); and, relatedly, it maximizes productivity, "... securfing] that whatever is being produced will be produced by people who can do so more cheaply than (or at least as cheaply as) anybody who does not produce it..., and that each product is sold at a price lower than that at which anybody who in fact does not produce it could supply it" (pp.259-260). Government redistributive policies ostensibly designed to provide a safety net for the market system's (relative) losers, or wastage, "has almost always meant one thing, and one thing only: the protection of certain groups against the necessity to descend from the absolute or relative material position which they have for some time enjoyed.... this is not a principle on which it is possible to act generally without destroying the foundations of the market order" (p.261). Not only does government intervention in the free market reduce the economic system's ability to adapt as required to constant change, thus reducing economic efficiency, but the government discretion involved also "... means in practice preservation of the traditional structure of incomes...[,] prices[, etc.]. An economic system in which each gets what others think he deserves would necessarily be a highly inefficient system - quite apart from its being also an intolerably oppressive system. Every 'incomes policy' [and other government intervention on grounds of social justice] is therefore more likely to prevent than to facilitate those changes in the price and income

structures [etc.] that are required to adapt the system to new circumstances" (p.262).

In summary, the market mechanism, according to the neoconservative model, is *adaptive* in the following sense. It is the means by which the economic system gathers economic information that cannot otherwise be known to the system as a whole (the knowledge of consumers and producers of the particular circumstances of time and place); the process operates continuously over time, so that the unpredictable but continual changes in this economic information are continually registered. 'The market' thus *searches* for the uncertain present data and unpredictable future information that constitutes most economically relevant knowledge. Having gathered this information it co-ordinates a self-regulating *response* to it, as consumers and producers mutually adjust their individual plans through the price system. The basic social value that this co-ordinated information serves is the maximum satisfaction of the diverse wants and needs, as they see them, of consumers. The market mechanism, according to the Hayekian model, is *primarily* adaptive (or appropriate to the best possible achievement of increased consumer satisfaction, the major economic goal), adjusting continually to the changes that are the inevitable product of time.

But can it be *ecologically adaptive* - a term which, as I have defined it, denotes a process that is appropriate to the achievement of the social goal of ecological protection? 'Ecological protection' means prevention of significant harm to valued natural assets through such processes as pollution, disease transfer, etc.. Is this damage of any account to 'the market'? 'The market' consists of producers trying to maximize their profits, by selling to consumers and by minimizing their costs, and consumers trying to maximize the 'utility'

they gain from buying. The more competition (for sales, and thus profits) there is between producers, the more consumers can pick and choose between their products, the lower the price of a given type of product may be as producers try to undersell each other (price competition), the more producers will be forced to produce what consumers actually want (quality competition), and the more they will be forced to minimize their costs (in order to continue to make profits at the lower, competitive prices, and/or to offset the expense of supplying a higher quality product) [8]. On the production side of 'the market', 'ecological damage' might enter into producers' calculations of how to maximize profits if that damage is a cost to their own productive natural assets, damaging this 'capital' stock or reducing the income it produces [9]. For this to be so, the firms in the market must *have* a productive natural asset - such as farmed salmon - which it is obviously consistent with profit maximization to protect from harm, such as pollution. Salmon farms thus have a profit-motivated incentive to avoid polluted areas and not to pollute themselves [10]. This is the only - and very limited - sense in which the profit motive of 'the market' has any bearing on ecological protection in this case.

The utility-maximizing consumer, who buys in the market, *could* have a little more influence. Consumers have the opportunity to boycott products that they know have been produced using ecologically-damaging processes, and in a competitive market in which consumers have most influence this could be effective in reducing ecological damage caused in production. Any such 'consumer regulation' of ecological damage is, however, extremely precarious, as I will explain below, not least because it depends on consumers' knowledge both of the ecological damage and of the causal connection between the productive process and such damage. Information about such causes and effects in salmon farming, as indicated in

Chapter Three, has been uncertain at the best of times.

So in very limited circumstances, and under highly specific conditions, 'the market' profit-oriented firms and 'utility'-seeking consumers - could achieve a limited amount of ecological protection. This would be largely incidental to the market's purpose, which is in maximizing man-made production of desired goods and services. But the overwhelming problem, of course, is that many ecological effects, by the very nature of dispersive ecological processes, are likely to occur outside the private property that is the realm of the market. This is the case in salmon farming, where *all* of the (possible) ecological effects - identified in Chapter Three - occur outside the exclusive private property of the net-pens. These effects are classic 'negative externalities' - harmful 'non-priced effects on third parties' - which even neoconservative economic theory concedes should be regulated by extra-market means if exclusive property rights, and thus the market, cannot be extended to encompass the resources they affect [11]. Negative externalities are by definition outside the scope of the market (competition-cum-price system) to discover and regulate; and if, as in salmon farming, they occur in the domain of a 'common property' resource (the marine and the fluvial environment), it falls to collective action government - to undertake any necessary discovery and to control or regulate them. (This is the adaptive process of search and response prescribed in Chapter One.) A government policy based exclusively on the market - entailing no government planning or regulation must fail in both these duties, and would not therefore be 'appropriately adaptive in ecological terms', or 'procedurally rational'.

#### The neoconservative model in policy and planning relevant to salmon farming

I have already detailed the relative lack of centralized planning in salmon farming development - evidence, I have suggested, giving sufficient grounds for belief that the philosophy underlying salmon farming policy was derived from neoconservative theory, which rejects comprehensive planning as inefficient and ineffective at meeting the major economic goals of society. It is worth reinforcing that conclusion by looking more closely at the general government attitude towards *intervention* in the salmon farming industry: any interference in the workings of the competitive market incurs similar neoconservative condemnation. The attitude towards intervention in the form of *regulation*, of course, is crucial in the control of identified negative ecological effects. And following the Gillespie Inquiry and the stronger recognition of such effects, significant regulation of salmon farming *has* taken place - under the 1988 additions to the B.C. *Waste Management Act*, for example. But what was the general approach to regulation in the important period before these changes took effect, when there was more doubt about ecological problems? A good indication can be found in the so-called economic policy 'context' already described.

The points of conformity between the strongly pro-market prescriptions of neoconservative theory and the recommendations of the Macdonald Commission are obvious: according to the Report, the market is to be favoured politically, for diffusing power and reducing government favouritism, administratively, for reducing the managerial demands on government (through the coordinating price system and market discovery), and industrially, for increasing productivity and growth. Generally, in fact - and in line with neoconservative theory - the Report leans towards keeping intervention to a minimum. The adaptive, productive capabilities of market competition are impeded by government

interference, which in many instances is not even necessary to safeguard collective values because of the regulating properties of market-based consumer sovereignty. Thus in industrial policy, since regulation "... can constrain competition and restrict improvements in productivity" (ibid., Vol.II, p.209), it should be reduced; while "... markets... locate essential decision-making processes concerning production and consumption in private hands, within a framework which, in general, provides a broad 'accountability', or responsiveness to the consumer" (ibid., Vol.I, p.43), so that "competition is the essential regulator" (ibid., Report Highlights, p.12), in that it maximizes consumer sovereignty.

Despite the presumption against intervention, government involvement is seen as unavoidable both in industrial policy and in provision for the welfare state, though it should be minimized in both. Thus in industrial policy government should at least make the minimal "... commitment to framework policies that encourage adaptation" (ie. promote competition) (Vol.II, p.205); and the welfare state, though it should be subjected to rationalization, or efficiency criteria, is an institution "debatable only at the margin" (Vol.I, p.46). At this contested state-market 'margin', the Commission - though as a whole it clearly favours the market - believes that environmental protection falls within the responsibilities of the state: regulation, renounced elsewhere, is necessary (Vol.II, p.527).

B.C. economic policies of the early and mid-1980's initially follow the same pattern. There is the same strong preference for the free market: the efficiency drive in the face of severe resource constraints (deep recession) would be led by the market mechanism, within which competition unfettered by government would maximize productivity and (the speed of) growth; "essential" welfare services - mainly socialized health and unemployment benefits - would be maintained, but these and other remaining government programs would

be subjected to radical rationalization in line with the marginalist principles of economics. Again this approach appears to be what I have called 'pragmatic laissez faire', following the minimal government spirit if not the exact letter of neoconservative theory [12]. But where B.C. policy diverges from the Commission's recommendations is at the 'margin' between esteemed market and disparaged state. For example, Kesselman suggests that the B.C. government's "... mini-efficiency approach lacks a clear understanding of the principles of economic efficiency as they apply to a complex world with externalities..." (1986, p.96), and describes specific instances of government deregulation which reimposed the 'external' costs of private actions on third parties (ibid., pp.85-6). According to the Macdonald Report, such externalities, including ecological ones, should have been regulated by government, being outside the scope of private control and hence beyond the reach of the market. The B.C. government managed to evade this responsibility, perhaps simply by ignoring the externalities. Aiming to cut "less essential" regulatory services it would "... reduce staffing while drawing more heavily on services offered by the private sector where appropriate" (MF, 1983, p.17); and salmon farming, operating from private property and itself sensitive to pollution, apparently presented such an "appropriate" situation, where most ecological protection could be by private industry 'self-policing' (see below and Chapter Five) - so long as few questions were asked about ecological externalities.

A similar position is apparent in the two Science Council-sponsored reports of 1984 and 1985, which, as suggested above, constitute the closest approximation of systematic planning for national aquaculture at the crucial, formative stage for B.C. salmon farming, and therefore the best source of specific information on policy towards the industry's

regulation during the pre-Gillespie period. The ideology of the market is again visible, with similar apologetic qualifications for pragmatic reasons. Thus, according to "Aquaculture: A Development Plan for Canada" (ITFA, 1984) [13], aquaculture development (the largest potential for which was in salmon farming, on the impressive example of Norway [14]) should be 'industry-led':

The primary objective in Canada must be to allow the private sector to establish an integrated profitable industry as rapidly as possible. Such an industry would not depend on ongoing subsidies from the public purse... (p.12).

... substantial commercial expansion... can only happen through initiatives from the industry itself - commercial viability for any industry depends on direction by the industry to meet the needs of industry (p.5).

Admittedly some planning, even government planning and participation, was necessary:

The market pull approach to development requires a well-organized industry. The fledgling aquaculture industry in Canada needs assistance to create and maintain a market-driven development plan. The recommendations in this [report] are an attempt by industry participants to initiate this market pull development process, and are intended to stimulate further discussion leading to concrete actions from all concerned agencies (ibid.).

Basically, though, government should merely play a supportive role for industry [15], which alone would make the decisions about what to produce and how, and bear the market consequences. In other words, government intervention - at least in the strict sense of command and control - is implicitly rejected. Thus government's so-called 'regulatory' role should be confined to "review[ing] all regulations relating to aquaculture to identify and resolve problems of conflicting jurisdictions, recognizing the importance of the private property aspects of commercial aquaculture" (ITFA, 1984, p.20). Nominal administrative 'regulations' should be streamlined, and there was impliedly no need for 'negative' control

regulations [16].

The reasons for the latter conclusion are expanded upon slightly in the 1985 Science Council "Statement" entitled "Aquaculture: An Opportunity for Canadians" (SCC, 1985). The phrase "recognizing the importance of the private property aspects of aquaculture" in the preceding report (above) appears to refer to the hypothesis in neoconservative (and neoclassical) economics that exclusive private property in a resource provides a powerful incentive to the owner to manage the resource rationally (and even conserve it, if profitable) [17]. The resource would thus be brought within the 'regulatory' compass of the market (which is what the economists effectively mean by 'rational' resource utilization). On the assumption that the owner has complete control of the resource - that there are no 'externalities' - there is no need for extra-market regulation, according to economics. 'Common property', though - which characterizes the wild salmon stocks of B.C. - does entail the existence of externalities, as fishermen compete for a limited resource and in so doing impose unpriced costs upon each other [18]. Private farming of salmon might appear, at first blush, to avoid this problem. Thus the 1985 Statement considers that "commercial aquaculture is a logical extension of [the economics-based measures to resolve the common property problem by devolving more exclusive property rights over wild stocks]. With fixed-enclosure aquaculture, the common property problem in harvesting is *eliminated*, providing the institutional framework for the efficient production of fish products from privately owned or leased farms" (SCC, 1985, p.12; italics added). In other words, if we assume that the salmon farm lease- or licence-holder has complete control of the owned resource - that there are no *ecological* externalities, for instance - then there is no need (if we accept economic theory about the market's rationality) for government

regulation. The two reports apparently made this assumption.

In hindsight this was unwarranted, since there are myriad opportunities for different kinds of 'escapes' - not least of farmed salmon - from net-pens (see Chapter Three and Appendix III). The false assumption may have been partly the result of the reports' shared presumption in favour of 'the market' and against government, which could lead to the implicit acceptance, in the absence of research to gather evidence pointing either way, that there were no ecological externalities. The attitude prompted in these reports about any costs of salmon farming - of course not explicit - was apparently 'if in doubt, ignore them' (see Chapter Five). The rejection of any need for 'negative' regulation, it seems, could not have passed scrutiny if there had been any research on the ecological effects of salmon farming at this time.

# 'Market planning': trial-and-error and ecological repercussions

In November 1986 the B.C. Gillespie Inquiry was initiated - some two years after the original 'take-off' of the salmon farming industry and since the Science Council reports - to investigate complaints by various non-industry "interest groups" [19] about potential environmental impacts and impacts on the commercial fishery, as well as a lack of local government and public involvement, and a perceived deficiency of "government approval and monitoring procedures" (Gillespie, 1986, p.1). It is worth describing in detail here one particular submission made to the Inquiry, in which Anne Levi-Lloyd, author of the Science Council's 1985 "Statement", elaborated on "... the general philosophical... attitude that I would like to urge on the provincial government" (Gillespie I, 1986, Parksville, p.59) - a "philosophy" which we can assume influenced the 1985 federal report. Though some
government involvement in salmon farming was inevitable (ibid., p.58), it should confine itself to putting "... in place positive policies rather than... negative restrictive regulations" (p.59). "Negative" regulations to control salmon farm siting adequately, for instance, already existed; the provincial bureaucrats "... already have the [necessary] ability, through the application process that exists right now - in other words, there is no need to create, as far as I am aware, new procedures or policies. They already exist, if they are enforced, to control site allocation" (ibid.). Even so, it was readily admitted that "... yes, there have been abuses of the process, there have been... rushes into error" (ibid.), but "... people rushing into it with insufficient knowledge of what is really desirable in a site... is, I would say, one of the *inevitable* kinds of things that will happen, probably, in any new industry when you are moving from the pioneer phase... to a more commercially viable industry which uses modern technology, which employs scientific findings..." (pp.56-7; emphasis added). The admitted developmental "mistakes" (p.55) were merely "growing pain problems that we will be able to overcome" (p.57), and were by implication integral to the necessary salmon farming learning process, for adaptation to "... the future [which]... is inevitably in fish farming.... we have to face [ie. adapt to] the future. I think if we turn our backs we will be further behind" (p.55).

The strong resemblance here to the neoconservative model, or 'philosophy', does not seem to be coincidental. I have already presented a range of evidence which suggests that neoconservative theory did have a major influence on salmon farming policy, particularly at the pre-Gillespie stage. A particularly important prescription from that theory is for allowing the trial-and-error 'discovery process' of the competitive market to work itself out; and the Levi-Lloyd submission seems to be a reiteration of the logic of that process. The

logic, as described before, goes something like this: approximate adaptive 'fitness' of firms to their environment is measured by their survival; survival is a function of profitability; profitability - under competition - means meeting changing consumer demands, and minimizing costs, or maximizing productivity (through technological improvements, for example). Thus the most productive and profitable conditions for salmon farm siting and operation - minimizing costs and meeting consumer demand most effectively - could be discovered by the industry as a whole through the winnowing process of trial-and-error, purely by utilizing the knowledge of the participants of the complex circumstances of time and place, without the need for costly, slow and ineffective comprehensive planning by government, made still more inappropriate by the complexity of and ignorance about the coastal environment.

Hayek is quite candid, as noted above, about the creation by this 'winnowing' process of both winners *and* losers: selection can only achieve fitness (adaptation) if failures are risked, even to the point of non-survival of some of the 'competitors' in what Levi-Lloyd calls "the game" (p.60). The utility of learning by this means was a rationalization still used by the provincial government in 1989:

... fish farming is here to stay. It may not be here in the form that it presently exists.... The companies that have gone into receivership recently have been bought up by other people, who will learn and run them properly from a productive aspect. New species will be the subject of culture... [etc.] (NWPS, 1989, p.26).

And the argument does not seem to have been merely an inconsequential (because after-the-fact) rationalization, but also deliberate, formative policy - though unsurprisingly, as a deliberate *omission* of government action, the 'leave it all to the industry' approach did not receive much concrete expression. The general policy 'approach'

(to siting of fish farms) was revealed in a rare moment of governmental candour by an MCL representative at a public meeting in March 1986: "as a matter of policy the aquaculture industry will be industry-driven. They will tell us where they wish to go rather than us tell them where they should or should not go" (The Fisherman, 18/4/86b; italics added). Effectively, as MCL's main 'technical' advisor in its referral procedure, any government responsibility over farm siting fell largely under the administration of the Marine Resources Branch (MRB; later MAF). Under MRB's administration of the salmon farm production plan, the tenure applicant was merely "advised" to assess the biophysical capability of the site (Gillespie III, 1986, MAF, p.3); thereafter he must merely perform "diligent and proper use" in conformity with the plan (p.5) - which itself only contained information he had himself gathered, reviewed by MRB, who might merely make "... suggestions regarding... methods to mitigate possible siting problems..." (ibid.). The picture that emerges of overall [20] government policy towards siting, before the Gillespie recommendations took effect, is one of deliberately minimal government planning: little substantive gathering of data about, or prediction of, siting conditions, and minimal restrictive regulation based on this information. The contention that this was deliberate policy is reinforced by statements made in the 1985 Science Council Statement: generally, there should be no restrictions on the industry - whether in size of plant or corporate structure or nationality of ownership - in order that it might evolve most effectively to meet the needs of the competitive market (SCC, 1985, pp.18-19) [21]; and, impliedly, little planning in the purely information-gathering sense was needed, because biophysical conditions, it was confidently assumed, were highly favourable: "site availability will not limit the development of an aquaculture industry in Canada" (ibid., p.14).

Evidence has since accumulated to show beyond any doubt that this assumption, based as it was on very little information, was erroneous. Following the recommendation of the Gillespie Inquiry that government undertake "urgently required" coastal resource planning studies (Gillespie, 1986, p.40), a comprehensive, though 'first-cut', study of biophysical conditions for salmon farming, in the regions where the industry was most heavily concentrated, was made in 1987 (Ricker, 1989). In the Sechelt Inlet/Sunshine Coast region, where nearly half the operating farms, and over half the actual and potential production, of all B.C. salmon farming were located by that date (Gillespie III, 1986, MAF, Summary Table), "... the zonation exercise revealed that there are no biophysically Good stretches of coastline..., and Medium reaches were difficult to find" (Ricker, 1989, p.viii). Almost the entire area was ranked either Not Acceptable or Poor for salmon farming, largely because of the "... extreme seasonal surface water dilution with freshwater [especially from the Fraser River outflow].... This layer of brackish surface water in turn provides a solar heat trap that warms the water and promotes plankton blooms" (ibid.). In the Sechelt Inlet system, an area with one of the heaviest concentrations of farms, there was additionally the serious problem of "upwelling of oxygen deficient bottom water" (p.74), and another popular.Sechelt/Sunshine Coast area, the Agamemnon Channel, was conservatively judged "... to have been overrated by those who have developed salmon farms in the area" (p.75). The frequent kills caused by two species of plankton which are deadly to different species of farmed salmonid have undoubtedly been a major contributor to the recent financial tribulations of the industry (Coopers & Lybrand, 1990, pp.52-54): some thirty percent of the companies involved are now in receivership, with the highest failure rate - over 50 percent - in the Sunshine Coast region (ibid., p.18). Though the timing and location of

plankton blooms is difficult to predict precisely (Steve Marsh, Sunshine Coast Aquaculture Resource Centre, pers. comm., 8/6/'90), the failure to avoid siting in areas prone to this problem is indicative of a wider negligence. There was no attempt before 1987, either by government or by farm applicants, to gather the range of background biophysical data that are relevant to plankton blooms and that were later quickly compiled - using existing data by a single consultant. Most tenure applicants in this region seem to have taken into account only those siting parameters relevant to short-term profits [22] - hence the attraction of the Sechelt area, with its good transportation links and proximity to the Vancouver market and to have taken little interest in the subtleties of seasonal oceanographic circulation, sediment accumulation and nutrient loadings, though it might have been in their long-term interests to do so [23]. Not surprisingly in these circumstances, many farms in the region have been sited in shallow and/or poorly flushed locations (Ricker, 1989, Appendix) [24] - conditions giving rise to the maximum risk of ecological degradation through waste sediment accumulation and water quality impacts.

Could this situation have been improved upon, all things considered, or were the siting mistakes "inevitable", as the submission from the Gillespie Inquiry quoted above suggests? In fact, the apparently dogmatic determination to avoid any semblance of government planning seems irrational, even judged against the assumptions of neoconservative theory. The neoconservative antipathy towards planning is based on an assessment of its inefficiency - since comprehensive data collection and co-ordination is expensive and must homogenize information; and of its ineffectiveness - at balancing the changing requirements of supply and demand, of producer and consumer, who best know their own particular circumstances and the most appropriate means of meeting their goals of profit-making and 'satisfaction'.

However, there is some information that producers, even firms with money to invest in planning, are not likely to know best. Thus Hayek actually approves of "... those true service activities in which government as agent of the people provides certain facilities, mainly in the form of information, which, at least in certain stages of development, is not likely to be provided in any other way" (1960, p.364). "It cannot be denied that there are some facts... which the government is more likely to know than most of the individual owners of natural resources. Many of the more recent achievements of science illustrate this" (ibid., p.371). The neglected technical background biophysical data alluded to above, especially information about marine processes with a large geographical scale, would fall into this category, and could, judging by the post-Gillespie overview study referred to, have been acquired cheaply, using pre-existing sources, prior to the industry's development. The cost of acquiring this advisory information at that time would almost certainly have been far less than the waste - including ecological degradation - that has in fact occurred in its absence [25]. If firms were unlikely to acquire more long-term technical biophysical information in general, this was doubly so with typically esoteric information about physically external ecological effects of siting [26], which would at most only marginally affect short-term profits. This of course is a complex example of a phenomenon noted above: 'the market' - in this case competitive firms with individual plans - is unlikely on its own to discover information about 'externalities', which have no bearing on profits. Government siting policy based (at best) on 'market planning' systematically failed to collect information relevant to ecological protection, and was not therefore 'appropriately adaptive in ecological terms' [27].

So market trial-and-error is not appropriate for discovering most information

relevant to ecological protection. It is necessary for discovering unpredictable market information. But in doing so it risks error, which should if possible be avoided, and can be if the relevant information has subsequently come to light. As Hayek says, "if anyone really knew all about what economic theory calls the data, competition [trial-and-error] would indeed be a very wasteful method of securing adjustment to these facts" (Nishiyama & Leube, 1984, p.254). And even in the relative absence of pre-Gillespie government data-gathering, some information (including Hayek's relevant 'data') had come to light about what would not be profitable or ecologically benign siting conditions. Thus 1986 "Interim Guidelines" for salmon farming regulation in Washington, based on "by no means exhaustive" overview data on water quality, recommended that some areas in Puget Sound (with low dissolved oxygen levels and susceptibility to plankton enhancement with the addition of nutrients) be barred to salmon farming, and that in others there should be restrictions on farm density (SAIC, 1986, pp.21-28). Based on the "deliberately conservative approach" of the Guidelines - to correspond to uncertainty about marine conditions (ibid., p.27) - the Washington Department of Natural Resources ordered in September 1986 that salmon farms should "encumber 2.0 acres or less of water surface area [and be] located in water at least -40 feet ... in depth and dispersed with at least one mile... separation between projects: except where it can be demonstrated an area under consideration has adequate tidal flushing to prevent excessive or harmful sediment accumulation" (Gillespie III, 1986, MAF Appendix (3)). In other words, there was enough information to establish that there was a strong risk of water quality impairment and harmful sedimentation in some geographical areas and shallow, poorly-flushed locations enough to restrict site allocation in those areas. The Washington report noted that "... in no

case is there a means to predict, a priori, what [nutrient] assimilative capacity may be" (SAIC, 1986, p.28), which justified the cautious approach. In B.C., by contrast, it could still be confidently asserted by MAF in its submission to the December Gillespie Inquiry that "at present there are only a few locations where nutrients may build up to the point that there would be measurable effects on... water quality; we have not yet reached this state in British Columbia and will not likely do so" (Gillespie III, 1986, MAF, App. E, p.1). A similar attitude towards ecological risk shown by the government agency responsible was noted elsewhere in the Report: "several examples were given of locations where site approvals had been made by [MCL] despite warnings by the DFO of inadequate natural conditions" (Gillespie, 1986, p.17). And even though extensive information about risks to water quality from poor siting was presented at the Inquiry, and though it was concluded there that this possibility in particular demanded increased government research (ibid., p.36), at least 26 tenures for the Sunshine Coast/Sechelt area - an area with already suspected water quality problems - were apparently released immediately after the Inquiry (cf. <u>The Fisherman</u>, 12/12/'86) [28], before any such research or siting regulation based on it could take place. These pieces of evidence suggest a doctrinaire attitude in early government policy, involving a repudiation of any restriction on farm siting or operation a determination to protect the 'freedom' of the anarchic market trial-and-error process even at considerable cost. Some of the 'errors', or mistakes, incurred - including potentially irreversible ecological damage - could apparently have been avoided, with little or no additional expenditure, had government heeded existing information about risks. As it was, Holling's "Titanic effect" epithet is apposite: "when uncertainties are wished away and not planned for, the crises that follow are all the more intense" (1978, p.134).

#### 'Market regulation': consumer sovereignty and ecological effects of salmon farming

Even in the absence of any significant information-gathering about ecological effects of salmon farming either by the industry or by government at the pre-Gillespie stage, some information about possible effects of farm operations did come to light. Obvious introductions were being made to the marine environment: large quantities of wastes and antibiotics, and a variety of chemicals, not to mention imported Atlantic salmon. These known introductions led to public fears about unknown ecological effects, fears that were if anything heightened by the lack of authoritative B.C. research. Public concerns demanded some kind of government response - but substantive action was difficult, both because of the government's commitment not to impose 'negative' regulations, and because of insufficient staffing either to undertake the research that might determine any effects or to enforce any resulting controls. As an MRS representative put it at an angry public meeting to debate Sechelt/Sunshine Coast salmon farm impacts in June 1986: "... it's the business community that sent a very strong message to this provincial government to get government out of business. Yet what you're hearing here from a lot of people is that they want more government involvement... and that requires more people and more money so we're all between a rock and a hard place" (The Fisherman, 23/6/'86).

A possible way for government to extricate itself from this predicament was to utilize the economic principle of 'consumer sovereignty'. As the Macdonald Report put it, "... markets... locate essential decision-making processes concerning production and consumption in private hands, within a framework which, in general, provides a broad 'accountability', or responsiveness to the consumer" (Macdonald I, 1985, p.43).

Conceivably, regulation of ecological problems and enforcement by government, as society's representative, would not be necessary if society in its role as consumer could adequately 'regulate' salmon farm operations in accordance with its collective wishes as expressed in the market. As a rationalization for lack of government intervention, this idea certainly seems to have been persuasive to government and to industry advocates [29]. At a public meeting in September 1989, for example, the president of the B.C. Aquaculture Research and Development Council (an industry research agency funded by MAF and the B.C. Science Council) put it thus:

Another point I want to touch on is how to protect the earth and ensure the proper development of aquaculture.... we must choose to eat foods that are best for our bodies and the planet. I think ultimately the choice is ours. I don't believe for a minute that there are companies that dictate what you do.... I've worked in advertising, I've worked in marketing, and... I noticed something very interesting. To go out and do market research we find out what people want and what people want is what we produce. It's very simple. If everybody tomorrow decided what they want and made it well-known to companies, companies are not foolish, they would produce what people want.... I think the market will drive the industry where the agriculture industry has been driven, which is toward more natural means (NWPS, 1989, pp.10-11, p.34).

The benefits of consumer sovereignty to the environment, not just human health, were also

implied by MAF representative AI Castledine at the same meeting:

There's a tremendous investment required [in salmon farming].... It's paramount, then, that the salmon farmer produce a product which is of the highest quality and *which is seen as such by the consumer*. This cannot be accomplished by shoddy practices, and the Salmon Farmers' Association is to be congratulated for its standards in the industry.

An example is TBT... a compound which was put on net pens five years ago to discourage algae growth.... When TBT was announced as having a negative effect on shellfish, the B.C. Salmon Farmers' Association [BCSFA] banned the use of the material (ibid., p.25; italics added).

In fact, this BCSFA ban followed publicity in B.C. given to Washington State reports of the

extreme ecological toxicity of TBT and of its discovery in the flesh of marketed farmed salmon there (see below; cf. SAIC, 1986, p.32). No B.C. government restriction on the chemical was made at this time. Indeed, the early policy conviction was apparently that the industry could be relied on to be largely 'self-regulating', making most government regulation unnecessary. For example, it was a positive recommendation of the 1985 Science Council Statement (which, as indicated above, seems to have had a formative influence on some aspects of salmon farming policy) that the industry association should play a major role in the "orderly development" of salmon farming. It could do so, and in fact needed to, because of the particular importance of the product 'image' in farmed salmon sales. Farmed salmon is a 'luxury' product selling in a competitive market where consumer perceptions are crucial to success or failure. (Significantly, B.C.'s largest salmon farming company before 1984, Apex Bio Resources, never accomplished high quality production (in terms of palatability) and went bankrupt in 1982 (Bourne & Brett, 1983, p.32)). For this reason product quality was repeatedly emphasized in both Science Council reports:

... marketing strategies must be based on consistent supply and quality assurance. This requires an informed and disciplined approach to marketing and close cooperation among individual producers through their organizations and interaction with government regulatory agencies....

.... Producer organizations are perhaps the most powerful force to influence the course of development of aquaculture.... They must work to *ensure the orderly development* of the industry... (SCC, 1985, pp.20-21; italics added).

The policy reasoning apparently went like this. The salmon farming industry had a strong interest in maintaining a high quality 'image' for marketing. The industry association would protect that image. Therefore the association could be relied on to regulate any industry production method that might taint consumers' perceptions of product and industry. Thus,

in the case of the antifouling use of TBT - virtually the only instance of a 'certainly' harmful ecological effect of salmon farming - the B.C. government refrained from regulating the chemical (from restricting its use and enforcing the restriction), apparently relying instead on the BCSFA ban to achieve the same effect (see below) [30]. By contrast, in Washington State at the same time, the "Interim Guidelines for the Management of Salmon Net-Pen Culture" recommended that government disallow TBT use (though none was at that time recorded in the state) (SAIC, 1986, p.32). In other words, the consumer sovereignty argument - for 'market regulation' - apparently *did* have a causative influence on ecologically-relevant policy (the apparently deliberate non-regulation of TBT, particularly), via the notion that 'orderly development' could largely be accomplished by the self-regulating industry association.

Does this policy reasoning stand up to examination? The basic argument in support of the regulating effectiveness of consumer sovereignty - formulated by neoclassical (which in this case would also encompass neoconservative) economics - is very simple, and can conceivably be applied to ecological effects. Consumers have (fixed) tastes, including, perhaps, desires for environmental integrity. If they discover that a product they are buying may adversely affect the environment, they will demand less of it. Through the interactive market mechanism, reduced demand will mean lower prices and thus reduced output of the offending product. For example, if consumers can discern a poor quality (unhealthy and/or environmentally unsound) farmed salmon from a high quality one, they will demand less of the inferior type, prompting reduction in its output (or improvement of its quality). (This is, of course, the basic argument behind 'Green Consumerism'.)

The starting point of this reasoning process is the perfectly competitive market model

of neoclassical economics. (See Chapter Five for a fuller analysis of this model, and the associated neoclassical notion of 'perfect rationality'.) One 'assumption' of this model - which neoconservatives like Milton Friedman believe is a reasonable approximation of reality [31] - is 'perfect information'. The consumer, for example, is presumed to be able to calculate the best means of 'maximizing his utility' in a market transaction - he can, it is assumed, accurately calculate the relevant consequences of his choice. This may in fact be true if the chosen product has obvious effects: if a farmed salmon is unpalatable or makes him ill he will know that it does not satisfy his taste for nutrition, for example. Direct experience of the product may not inform him of its more esoteric characteristics, however. Assuming he has a 'taste' for health, the consumer is likely to be significantly underinformed about imperceptible, long-term health hazards, for instance:

The perfectly competitive model... presumes that all parties to a transaction have access to the relevant information. In practice people are frequently underinformed. A consumer buying a personal computer has no way of assessing the dangers from radiation emitted by the monitor. If radiation screening is expensive [for the firm], and consumers cannot tell safe radiation levels from unsafe levels, then firms will have an incentive to provide too little radiation screening. In such cases it is often better simply to have the government impose standards for the product (Brander, 1988, p.27).

In other words, mainstream economics recognizes that 'perfect information' is not always a realistic assumption - particularly when significant technical properties of the product are involved - and prescribes government intervention to redress this (informational) 'market failure'. 'Pure theorists' like Friedman disagree over the necessity for intervention, and differ from mainstream neoclassicists at least over the *degree* of realism and generality of the model's assumptions [32]; for the 'purists', "perfect competition [including perfect information], in a sleight of epistemological hand, is said to describe the best possible *as* 

well as the actual world" (Kuttner, 1985, p.74; italics added).

The 'consumer sovereignty regulation' of ecological effects of salmon farming can make sense only if the assumptions of the perfectly competitive model are believed - following Friedman - to be good descriptions of reality. Assuming, first, that many farmed salmon-buying consumers gain utility from knowing that the product is environmentally sound: second, that they are fully informed about whether it has been produced using environmentally sound techniques; and third, that they act rationally on that information then consumer choice could (eventually) lead to a reduction in environmentally unsound salmon farming techniques. In fact, of course, most consumers may not care about the salmon farm environment (they may gain no significant 'utility' from its protection); they are likely to be poorly informed about the technical and uncertain ecological effects of the novel production processes in salmon farming (they do not have 'perfect information'); and they may not act on what they know (they are not perfectly rational). Consumers may not care and do not generally know whether a farmed salmon offered for sale is produced using ecologically harmful methods; consumer demand cannot be relied on as a consistent means of controlling those methods and their harmful effects. So the market is not a credible instrument for the orderly regulation of the ecological effects of salmon farming.

But the market *does* react - especially in the absence of independent information about ecological impacts and related health hazards provided by government - to public rumour and health scares. That seems to have been the case with TBT - held out as the pre-eminent example of 'market regulation' of health and environmental problems in B.C. salmon farming. The chemical, known to be toxic to shellfish, was first found in marketed farmed salmon by researchers from the U.S. National Marine Fisheries Service in September

1986, in Washington State (The Fisherman, 11/'86). At this time, the B.C. government had "... no controls on the use of anti-fouling agents", according to a spokesman (ibid.), and TBT had not even been registered for use as a net-pen anti-foulant (ibid., 25/3/87). Its use had, however, been common by early 1986, according to MAF (ibid.). It apparently took the Fishermen's Union (UFAWU) to make public in B.C. evidence of the chemical's human health risk, at the December 1986 Gillespie Inquiry (Gillespie, 1986, p.18); B.C. government studies were not completed until March 1987, when they duly found the chemical in farmed salmon tissue (The Fisherman, 22/5/'87). Meanwhile, following the publicity given to its harmful effects at the Inquiry, and "... worried about [the] recent U.S. studies which found TBT in farm fish being sold to the public" (ibid., 25/3/'87), the BCSFA directed its members not to use the chemical in January 1987. In contrast to Washington State, as mentioned above, the B.C. government merely advised salmon farmers not to use TBT, implying there was no provincial jurisdiction to restrict it (The Fisherman, 22/5/'87). As outlined in Chapter Three, five farms were probably still using TBT by the fall of 1987, and even though the chemical had by now been officially banned by government, a memo 'leaked' by DFO biologist Rob Russell in August 1988 claimed that "... some sites may still be using TBT-treated nets". Government enforcement, it was implied, was inadequate to control the chemical's use (ibid., 21/4/'89).

The example of TBT suggests that 'market regulation' of a salmon farming ecological impact - its regulation, or reduction, in the absence of government research, restriction and enforcement - *can* be effective, but only under very limited conditions and to a limited extent. Given that ecological impacts are not discernible to the consumer merely from examining the fish and perceiving its 'quality', the information about such impacts, if there

is to be any market regulation, must come from an outside source. Government, I have already assumed, has abdicated this role. The industry association, fearing any taint that might reach the consumer, clearly will not be the source, either. So publicity must come from the media, interest groups, individual members of the public, etc.. This publicity must be sufficiently dramatic to reach and impress significant numbers of potential farmed salmon consumers. The production method publicized should involve a dramatically toxic substance with a very likely or certain ecological impact and/or a human health risk (preferably the latter: *all* consumers can be assumed to have a 'taste' for health). Undramatic ecological effects, such as sedimentation and effects on water nutrient quality with uncertain ecological impacts and no significant health effects - would not generate the publicity or achieve the necessary impression on consumers. And even if the damning publicity does occur, or is anticipated by the industry association which then imposes a ban on the substance in question, there may be a lag before individual producers stop using it, because if the substance is undetectable to casual observation and the product is not inspected by government, there may be a profit-motivated incentive to keep using it: its use presumably reduces costs, and will not, if it is undetected, reduce sales.

Furthermore, (even false) publicity itself depends on some persuasive information if it is to make an impression on consumers. The scientific reports from Washington State on TBT, for example, were evidently persuasive evidence when publicized in B.C.. But the timing of the B.C. publicity was in a sense accidental: it depended on an interest group obtaining persuasive evidence from abroad, rather than on methodical B.C. research, which would have discovered the use and toxicity of TBT much earlier. (Its toxicity was known in Washington in 1985 (Hall & Pinkney, 1985); it was probably used in B.C., but was not

even registered, at that time.) In other words, publicity is not even a reliable vehicle for 'regulating' dramatically toxic substances: the publicist must first discover that they are toxic and that they are being used in B.C.. In the absence of B.C. government research, the toxicity information will have to come from abroad; and the information on use will be largely fortuitous. The toxic pesticide Nuvan is a case in point. It is presently unregistered but unrestricted in B.C. (MAF 29, 1990). Information about its probable toxicity has been obtained largely from European salmon farming experience; and its present use is unknown but not inconceivable in B.C. (Al Castledine, MAF, pers. comm., 23/1/'91). If it is used, that use is undocumented, and cannot be 'regulated' by publicity. In fact a range of pesticides with possible ecological toxicity is thought to be used in B.C., but exact uses are publicly unknown (ME, 1990, p.20) [33].

In summary, 'market regulation' by consumer choice can be effective only where consumers are informed about how their market choices affect their goals (or 'utility'). We cannot assume they are fully informed (ie. have 'perfect information') about how to choose so as to further any environmental goals, since environmental information often is not provided in 'the market': in the present case, it is not discernible by inspecting the product; and the producer association does not have an interest in providing it. (Even if ecological impacts are linked to *health* impacts, so that we can assume *all* consumers have a strong self-interest in avoiding affected products accordingly, the health risk may well not be detectable by inspecting the product, because of the technical nature of the chemical, etc., risk involved; producer associations have an interest in protecting their product's quality 'image', but this certainly does not entail providing consumers with environmental information to be producer association to be detectable by inspecting the product.

ensure orderly development, because order is conducive to a good image, could just as easily be a recipe for suppressing any damaging information as for regulating member producers.) In the present case, then, environmental information will only emanate from extra-market sources; and in the absence of commercially-independent government research it must derive from interest groups, etc., with all the vagaries of publicity that that entails: accidental, untimely discovery, for example. A publicity-inspired ban by the industry association will not, in the absence of government enforcement, prevent delay in response by individual producers, either. Publicity, also, is only likely to be of relevance to dramatically toxic environmental effects. In short, consumer sovereignty (itself a misnomer in this case) is an extremely unreliable and precarious tool for regulation of ecological effects.

## <u>Conclusion</u>

Clearly, according to the preceding analysis, government policy towards salmon farming has been in principle a laissez faire one, based primarily on allowing 'the market' free rein - on minimizing government planning and regulation of the industry. A basic assessment of whether this policy was appropriately adaptive in ecological terms can be made simply by re-examining the market's main features. The market, for present purposes, is comprised of producers and consumers, the former seeking profits, the latter, 'utility' from consumption. The economic market system as a whole in effect 'gathers' the scattered information relevant to these individual goals, and coordinates it in response to them through the price system. Only information related to those goals and capable of being handled by the price system is relevant to the basic market mechanism. This 'mechanism'

for maximizing consumption values, by definition, excludes 'externalities' - non-priced effects on third parties - which have no bearing on profits, no necessary connection with the utility gained from consumption, and are obviously not part of the price system. All the (potentially) harmful ecological effects of salmon farming are externalities. A government policy based solely on 'enabling' the market - one repudiating government planning and regulation - in effect systematically shirks the social responsibility of ecological (externality) information; so it is not stretching a point too far to say that government policy based solely on the market is systematically biased against information relevant to ecological goals. Bias against important information, according to my previous analysis, is procedurally irrational: regardless of the *outcome* of government policy - and uncertainties remain about whether there has been or will be significant ecological damage resulting from this policy - the 'market-pull', or 'market-driven approach' is not a type of *procedure* that is conducive to the social goal of ecological protection.

To support government's commitment to minimizing its planning and regulation of the industry, various arguments were offered to the effect that the market could be 'stretched' to perform some of these functions instead of government. One was the "self-policing" argument which, since it exhibits characteristics of the rational model used in neoclassical economics, is discussed more fully in the next chapter. Suffice it to say here that reliance on individual firms to act rationally and minimize costs - especially in 'Gold Rush' circumstances where many firms apparently pursued short-term profits without much attention to long-term costs - and thus to protect the environment, was misplaced, and therefore not conducive to orderly regulation of ecological effects. Given the reality that

economic agents are often underinformed about how to achieve their goals, and may not act with rational consistency anyway, relying on consumers to achieve ecological protection by supposedly maximizing any utility they might have in doing so, is similarly inappropriate. Any 'regulation' through this expedient is likely to be erratic and disordered. Indeed, to call on the market for these purposes is to attempt to stretch it well beyond its limits. So the conclusion that *government* planning and regulation is necessary to achieve effective ecological protection still stands.

The commitment to the market, and against central planning in general, also seems to have led policymakers to a number of false and uninformed empirical assumptions which would obviate the need for such planning: the assumption that the salmon farmer would have full control of the resource (which thus was assumed to be co-extensive with private property rights and under the domain of the market); that there would be no biophysical siting problems, which might necessitate extensive planning; and that there were no informational market failures (though this assumption is not explicit, but is deeply buried, amongst the premisses underlying consumer sovereignty). The same free market commitment may have led to the failure of government to provide inexpensive background technical information that the market was unlikely to provide; and to the failure to restrict inappropriate siting, when adequate, costless information about the risks of some locations was available. These mistakes were avoidable even in the difficult budgetary circumstances of the early-to-mid 1980's.

The major ecological problem here, though, and the main ecological failure of a government policy based primarily on the market, is the fact that ecological externalities are outside the market's compass: the market does not 'seek' information relevant to the

collective goal of ecological protection, and it cannot therefore co-ordinate it to respond to society's wishes. Neoclassical welfare economics - many of the prescriptions of which are very different from those of neoconservative economics - recommends government intervention to *regulate* such externalities. Its prescriptions, if any, for *discovering* the relevant ecological information - on which regulation depends - are the principal subject of the next chapter.

# Notes 1

[1] See under my analysis of the neoconservative model, below, for fuller explanation of these views.

[2] This epithet originates in the August 1984 report of the Industry Task Force on Aquaculture, entitled <u>Aquaculture: A Development Plan for Canada</u>. This was the closest attempt at producing a comprehensive development plan for salmon farming - but not all that close, as indicated below.

[3]

"1. Decisionmakers are assumed to agree on the goals that govern a given decision;

2. Decisionmakers identify all alternative courses of action that are relevant to their goals;

3. Decisionmakers identify all relevant consequences of each alternative; and

4. Using some appropriate calculus, decisionmakers compare the sets of consequences and decide upon the optimum alternative."

(Quoted in Culhane et al., 1987, p.2).

[4] Salmon farming was by far the most significant element, over most of this period, of the 'aquaculture' referred to in several of the planning instruments and analyses cited.

[5] A more detailed analysis of the task force's main recommendations is provided below.

[6] The relevant brand of rationalism here, as described before, is the belief that reason alone is capable of fulfilling all social goals - through the collection of comprehensive information about the present and through comprehensive (fully accurate) prediction about the future.

[7] Having been prepared in conjunction with, and for the benefit of, the aquaculture industry (Fralick, 1988, p.ii).

[8] Cf. Eckert & Leftwich: "The organization of production [by the price system] involves (1) drawing resources from industries producing goods that consumers value less and channeling them into industries producing goods that consumers value more and (2) efficient use of resources by individual firms.... The quest for profits provides the primary incentive for efficient production" (1988, p.20).

[9] In 'the market', privately owned natural resources are usually treated as capital assets producing income. As Hayek puts it, "from a social as well as from an individual point of view, any natural resource represents just one item of our total endowment of exhaustible resources, and our problem is not to preserve this stock in any particular form, but always to maintain it in a form that will make the most desirable contribution to total income" (1960, p.374). If the regular income derived from the natural resource is less than the normal rate of return on capital - if the return on this natural 'capital' is less than its opportunity cost - it should be liquidated and the proceeds invested at a more appropriate rate elsewhere (in a bank, for instance): "... all resource conservation constitutes investment and should be judged by precisely the same criteria as all other investment. There is nothing in the preservation of natural resources as such which makes it a more desirable object of investment than man-made equipment or human capacities; and, so long as society... channels its investment in such a manner that its aggregate income is made as great as the funds available for investment can make it, there is no further economic case for preserving any one kind of resource. To extend investment in the

conservation of a particular natural resource to a point where the return is lower than the capital it uses would bring elsewhere would reduce future income below what it would otherwise be" (ibid.).

[10] The latter is the basis of the 'self-policing' argument, discussed below.

[11] Hayek's *preference* for dealing with 'negative externalities' is to extend exclusive private property - and the market - over the resources they affect: " many of the more serious defects in the working of the price mechanism [such as negative externalities] can be remedied only by the evolution of appropriate units of enterprise under single control" (1960, p.365); "... rational use [will occur] only if the scope of unified control is made coextensive with the range within which the same resource can be tapped" (ibid., p.369). However, he concedes that "... 'fugitive resources', such as game, fish [and] water..." may produce "... situations in which... private property cannot exist.... It is undeniable that where for such technological reasons we cannot have exclusive control of particular resources by individual owners, we must resort to alternative forms of regulation" (ibid.).

[12] An apparent departure from neoconservative prescriptions is in the B.C. government assistance offered to industry - the "policy of selective stimulation" of the private sector (MF, 1984, p.3). Aquaculture was singled out for particularly favourable treatment in the early 1980's, for example (MF, 1985, p.10). But rationalizations for effectively subsidizing industry in this way - lengthy justifications involving distinguishing the structural nature of the government problem (entailing a reduction in *its* size) from the cyclical nature of the business one (requiring *increased* spending on industry) in the budget speeches at the time (eg. MF, 1985, p.5) - in fact seem to comprise further evidence that the B.C. government policy 'philosophy' was a basically neoconservative one, so much so that it found it important to deny in this way that it was making any compromise of the free competitive market system.

[13] Though produced by "... a Task Force representing private sector interests", this report was seen as "... a first step toward preparing coherent national policies and a development plan for Canada", and was set within the context "... of managing the natural resources of Canada to maximize economic and social benefits" (ITFA, 1984, p.5): it was apparently intended to be a major input to specific government policy towards salmon farming, disinterested to the extent that industry interests and government aims were apparently assumed to coincide.

[14] The 1985 Science Council of Canada aquaculture "Statement", for example, gave prominence to the fact that "by 1983 Norway produced 22,703 metric tonnes of salmon and trout. Production in 1984 is projected to reach 25,000 tonnes with a first-hand sales value of more than US \$100 million" (SCC, 1985, p.10).

[15] The primarily supportive role envisaged for government, and its confinement largely to an administrative function, can be inferred from the following statement (among others): "The primary objective of a national policy must be to foster and sustain the productive sectors.... A national policy should also [ie. secondarily] define the responsibilities of... government in relation to the administrative and regulatory aspects of the industry" (ITFA, 1984, p.20).

[16] Thus, although the need for clarifying government jurisdictional mandates is repeatedly asserted (ITFA, 1984, pp.14, 20, 21), not one of the ten recommendations in the report for government involvement (ibid., pp.20-21) could be construed as a 'negative' regulation, addressed to interests other than the industry's.

[17] Thus, according to Hayek, "... the depletion of the [U.S.] forests... was largely due to the fact that they did not become private property but were retained as public land and given over to private exploitation on terms which gave the exploiters no incentive for conservation" (1960, p.368).

[18] "The economic problems associated with the exploitation of common property resources arise from the interdependence of production among co-producers. These interdependencies, or externalities, are affected by institutional arrangements, especially the system of property rights, under which exploitation takes place.... Common property problems arise not from a dearth of rights but from a plethora, all insufficiently exclusive to provide the holders with adequate control over their inputs and protection from interference from others" (Pearse, 1980, p.202).

[19] So called in the Report (Gillespie, 1986, p.1) - particularly the United Fishermen and Allied Workers' Union (UFAWU) representing commercial fishermen, and coastal residents from areas affected by salmon farming.

[20] DFO, through the referral process and its aquaculture licence, also had an input into siting - but confined, it seems, to a relatively minor one because MCL favoured MRB/MAF in any conflict (Gillespie III, 1986, MAF, p.3): the DFO aquaculture licence was actually considered ultra vires by the province (ibid., p.1). The DFO input seems to have been largely confined to restricting location in close proximity to (within half a mile of) salmon bearing streams and other salmon farms (eg. <u>The Fisherman</u>, 19/9/'86).

[21] "If we are to be competitive, we must become effective in applying leading-edge technologies in goods and services....' The basis of a successful aquaculture industry will be a core of integrated, self-sufficient companies... that use the most advanced technologies available..... These operations need several million dollars in investment [etc.].... When such enterprises are fully established, smaller grow-out operations can prosper. However, the front-end costs are high... [so] it may prove difficult to attract domestic capital. To make the transition from pioneering efforts in aquaculture to a highly capitalized industry employing sophisticated technology, [several] sources of capital could be tapped: [e]xisting Canadian aquaculture enterprises could achieve the necessary rapid growth by entering into joint ventures with large firms that have capital to invest. These might include... Canadian firms with an interest in fisheries, related resource-based firms, or the food industry. They could also include foreign firms that already have expertise in aquaculture.... Canada may ultimately have to depend on a judicious blend of foreign and domestic capital to develop this sector, despite the tradition of giving preference to Canadian capital" (SCC, 1985, pp.18-19).

[22] The 1986 Gillespie Report, for instance, referred to "the 'gold rush' image which now pervades the finfish aquaculture industry" and "... the image of rampant and uncontrollable development" (Gillespie, 1986, pp.9, 11) - perceptions which were partly the result of the hasty and little-planned inaugurations of a substantial number of salmon farming operations.

[23] Ricker notes the importance of large-scale geomorphological and circulatory patterns - which are major influences on the Sechelt dilution-plankton and oxygen deficiency problems: "Fjords and fish farms are not very compatible features. The hydrologic/geomorphic... implications can be significant.... it is essential that potential geological hazards... be investigated. In the past, most site capability assessments have not included a consideration of geological factors" (1989, p.85). Equally, "current velocity data submitted with most applications [have been] inadequate" (ibid., p.86), indicating a

lack of concern with sediment accumulation below net-pens, which stronger sub-surface currents might prevent.

[24] Some of these sites are so poor that they have subsequently been rated "Not Acceptable... [which] excludes any possibility of a net pen farm" (Ricker, 1989, Appx.).

[25] This has evidently been the view in Alaska, an area with similar relevant environmental assets, where a moratorium on salmon farm licence issuance was imposed in August 1985, before any farms were built, and continued in July 1987 "... pending the development of a comprehensive aquaculture policy" and coastal resource inventory (<u>The</u> <u>Fisherman</u>, 16/8/'85 & 17/7/'87).

[26] *Physically* external ecological effects of bad siting - of locating in areas with poor depth and flushing - could include not merely the smothering of benthic organisms (of no relevance to farm profits - thus an *economic* externality), but also more subtle changes in water quality, such as nutrient loading, increased BOD, changes in plankton production, and production of noxious gases (see Appendix III), all of which could affect the farm, and are not therefore *solely* economic externalities, or non-priced effects on third parties.

[27] The ME submission to the Gillespie Inquiry supports the conclusion that siting information relevant to ecological protection was in effect systematically ignored in the overall government process. ME complained about the lack of government planning for siting in general, and particularly about the lack of planning to avoid the ecological impacts of bad siting. It was concerned about "the absence of a strategic approach to the allocation... of the 'aquaculture resource'... [and] the lack of adequate consideration and weight given to... environmental impacts in the adjudication of aquaculture applications" (Gillespie III, 1986, ME, p.10).

[28] "Gillespie concluded the industry needs a complete regulatory overhaul of virtually every aspect of its operation, but added in the next breath that salmon farmers could not tolerate a continued moratorium while new controls are implemented. The result: more than 200 new salmon farm permits are being issued under the existing regulatory structure while the government scrambles to put a new one in place" (<u>The Fisherman</u>, 12/12/'86). The newly-issued tenures would have included at least the 26 Sechelt applications with production plans approved before the Gillespie Inquiry, but not due to begin operating until 1987 (Gillespie III, 1986, MAF, Table 3).

[29] As late as February 1989, in the related area of regulation of health effects, Jim Anderson, director of the Aquaculture and Commercial Fisheries Branch of MAF, remarked - in reply to concerns that diseased or unwholesome farmed salmon were being processed for human consumption - that "the market will enforce a lot of this" (ie. control any such practices), an expedient that was evidently necessary because the government did not at that time have the requisite inspection capability: new regulations were still being prepared to require farmers to document medication and certify that fish were free of drugs before processing (The Fisherman, 17/2/'89).

[30] The B.C. government merely *advised* salmon farmers not to use the chemical, implying there was no provincial jurisdiction for control until the fish entered the processing plant (The Fisherman, 22/5/'87).

[31] For Friedman, for instance, the economic agent can at least be said to act 'as if' he had perfect information: it is a reasonable "... economic hypothesis that under a wide range of circumstances individual firms act *as if* they were seeking rationally to maximize their expected returns... and had full knowledge of the data needed to succeed in this attempt..." (quoted in Hahn & Hollis, 1979, p.32).

[32] As Kesselman says, "where [neoconservative economists] part company with other economists is in their unwillingness to recognize the real-world existence of major departures from perfectly competitive conditions" (1986, p.82).

[33] "Pesticides which are used in the marine fish farming industry include antifoulants, fungicides, parasiticides and wood preservatives. The extent of their use by this industry has not been documented in B.C.. Marine environmental effects, including fate, persistence and impacts on non-target organisms are poorly understood. None of these substances are registered yet... for use in the marine environment for fish farming purposes" (ME, 1990, p.20).

## CHAPTER FIVE

## POLICY DETERMINISM

### Indications of neoclassical influence in salmon farming policy

I have chosen in this thesis to draw a somewhat artificial distinction between so-called "neoclassical" and "neoconservative" 'models', partly for purposes of simplified exposition. In fact, it could be argued that the neoconservative model - insofar as it can be delineated as such by identifying it with the influential writings of individuals such as Hayek - is largely, but not wholly, a subset of the more broadly-based neoclassical economics, with which it has in common a faith in the Invisible Hand of the market. Welfare economic theory, on the other hand, *is* wholly a 'subset' of neoclassical economics: not only does it share this same 'faith', but it is characterized, in addition, by a deterministic form of analysis of economic decision-making, which, I shall argue below, typifies mainstream neoclassical economics. By contrast, the neoconservative model - at least the Hayekian version - is based on an indeterminist, evolutionary metaphor, and is in this way distinct from neoclassical theory. In this chapter I shall attempt to identify *distinctively* neoclassical influences on salmon farming policy - ones characterized in some way by determinism.

The conclusion of the last chapter was one that in principle neoclassical welfare economics would support: 'the market' does not adequately address ecological issues such as those resulting from the development of B.C. salmon farming, which are primarily a matter of collective values, and are basically not relevant to the individual goals of consumption and profit fulfilled through private exchange. Most ecological protection values can only be satisfied by some form of collective, non-market action - most obviously, through

government planning. Thus neoclassical welfare economics prescribes government intervention in the market - central planning - to redress negative ecological externalities.

For purposes of the present analysis of ecologically-relevant policy, the neoconservative model differs most significantly from distinctively neoclassical theory in this area of central planning, and particularly over the rationalism that underlies it. Although the two models share a strong belief in the allocative efficiency of the private market, mainstream neoclassical economics far more readily admits the existence of 'market failures' - situations where the unfettered market is not appropriate to the rational allocation of scarce resources - and prescribes government intervention to address them. Neoconservative economists, by contrast, do not happily recognize the real-world existence of significant departures from the perfectly competitive model (such as externalities), and "... further object that governments tend to do things wrong or to be swayed by special interest groups - so that it is often better to have governments do nothing than to do the analytically correct thing [from a *neoclassical* point of view]" (Kesselman, 1986, p.82). The 'government failure' that neoconservatives emphasize stems partly from the inefficiency and ineffectiveness of rationalist central planning:

Hayek's anti-rationalism tells us that all planning is wrong and misguided.... Not only are we unable to control the course of social evolution; even to attempt to do so deprives us of the benefits of spontaneity and decentralised human action. He now argues that... spontaneous evolution will *select* those... practices which prove to be successful in the struggle for existence. In other words, an unaided reason can never improve on experience (Barry, 1984, pp.60-61).

Neoconservative theory thus offers little guidance on how government planning - *reasoned deliberation* about how to achieve social goals - should be conducted when it occurs (as of course it does, extensively (Solo, 1975, p.105)). So even though, as I have suggested,

government policy towards salmon farming was primarily a neoconservative one, it is reasonable to hypothesize that distinctively neoclassical (welfare economics) theory was applied to whatever government planning in fact proved to be necessary. Under laissez faire, as I suggested in Chapter Two, planning "... of the *public* sector follows the strictures of *neoclassical* thought in deducing... criteria as guides for the formulation of public policy, with the initiatives, outlook, and opportunities for public action understood and explained as no more than residuals in an occasionally imperfect universe of private choice and market exchange" (ibid., p.111).

It is worth looking in a little more detail here [1] at what I mean by 'distinctively neoclassical theory', in order to help identify areas of ecologically-relevant salmon farming policy that may have been influenced by it. Of course neoclassical theory has in common with neoconservative thought what has been called the 'apotheosis' of the market. But the other distinctive feature of neoclassical theory - a methodological commitment that is actually derided by neoconservatives such as Hayek [2] - is its conscious imitation of important aspects of the science of physics:

Neoclassical economic analysis grows out of the Enlightenment mentality, which substituted a scientific natural order for a metaphysical one. An invisible hand that shaped individual egoism into general harmony reconciled the Enlightenment predilections for personal liberty and natural laws. Adam Smith's concept of equilibrium in market economics is also a variation on eighteenth-century Newtonian mechanics. Physics has served ever since as a model to which economics should aspire (Kuttner, 1985, p.76).

Though like all natural sciences physics has an empirical side, what distinguishes if from other investigations of nature is "... its formal and deductive aspect" (Daly & Cobb, 1989, p.26). Many other sciences aspired (though unsuccessfully) to the precision and

certainty of the laws of Newtonian physics, and "... the ideal of science was established as the discovery of laws from which facts could be deduced" (ibid.). The deductive method used in physics - drawing out logical implications from simplified but empirically well-supported abstractions, or laws - allowed important predictions to be made; physicists discovered that "to explain empirical phenomena, it was necessary to develop models that simplified reality in order to bring out fundamental features. The right abstractions" (ibid.). Neoclassical economics has imitated the deductive method of physics; in fact "classical economics has always been based on the assumptions of [what Simon calls] substantive rationality and an optimizing goal - a theory of best solutions. These important assumptions [or abstractions] have allowed economists to develop and refine powerful explanations by emphasizing 'deductive reasoning within a tight system of axioms" (Bartlett, 1986, pp.224-5).

One of the most important abstractions of neoclassical economics is *homo economicus* - the famous, if hardly human, 'rational economic man'. This conception of the economic decision-making 'unit' in effect embodies [3] neoclassical economics' deterministic notion of rationality - or "substantive" rationality, as Simon has termed it. In the barest essentials of the 'pure' (neo)classical theory, the rational economic man "... knows his 'preference function' (goals), has 'perfect information' (ie. about alternative actions and their consequences), and chooses the action with the highest 'net benefit', that is, the one with the best mix of goal accomplishment and side effects" (Culhane et al., 1987, pp.2-3). Simon calls these characterizations of the rational economic man "... the over-simplified assumptions of the situationally constrained omniscient decision-maker" (1976, p.147), which are at the core of neoclassical economics' "program of situational determinism"

(ibid., p.130). The rational economic man, according to the pure theory, is constrained in his decision-making only by the limits imposed by his environment, not by any intellectual shortcomings of his own: in effect there are no constraints on his mind or limits on his mental abilities [4]. In fact, "... the rationality of behavior depends upon the actor in only a single respect - his goals. Given these goals, the rational behavior is determined entirely by the characteristics of the environment in which it takes place" (ibid., p.131). The economic actor is assumed to decide in accordance with the objective requirements of the situation for optimal choice, and thus to 'maximize his utility', equating his costs and benefits 'at the margin' (which ensures a maximum divergence between the two). An assumption of the basic model is therefore that the economic actor can calculate, or foresee, the (beneficial and costly) consequences of his choice, which must be known in order to maximize the differential. "The classical model calls for knowledge of all the alternatives that are open to choice. It calls for complete knowledge of, or ability to compute, the consequences that will follow on each of the alternatives" (Simon, 1979, p.500). This is what is meant by 'perfect information', the assumption that the economic actor can accurately predict the effects of his choice. Under the basic neoclassical model, therefore, using "... the usual approach from the ... extreme of accurate foresight", uncertainty (about the future) is regarded as "an aberrational exogenous disturbance" (Alchian, 1950, p.221), and can only be included as a subsequent 'refinement' of the model.

This is the basic structure of the rational decision-making model used in neoclassical welfare economics, which, I have suggested above, is the major neoclassical contributor to the prescriptive analysis of government planning. As Brooks puts it, "the intellectual roots of rational policy [planning] analysis and choice can be traced to the development of welfare

economics. This is a branch of economics that studies the conditions under which the welfare of society can be maximized, within the constraints imposed by scarcity of resources" (1989, p.68). Welfare economics is the progenitor of the policy analytical techniques of cost-benefit analysis and program-planning-budgeting already mentioned in this thesis. These techniques thus share the basic methodology of the rational decision-making model: "goal selection, identification of alternatives and their consequences, and an optimizing decision" (Culhane et al., 1987, p.5). Such techniques of rational policy analysis provide a means of calculating the efficiency and effectiveness of government programs and plans.

It was presumably with techniques of this type in mind that the Macdonald Commission recommended the application of efficiency standards to government services ("We properly... apply efficiency criteria to our social policy instruments" (Macdonald I, 1985, p.47)). Such criteria were applied to government programs by the 1984 Task Force on Program Review, which evaluated the regulatory activities of DFO [5]. Given the social welfare goal of maximizing the economic efficiency of the Canadian fishing industry, DFO's basic regulatory responsibility was to manage fish stocks - the health of which is obviously a prerequisite for the industry's economic efficiency - at an optimal exploitation level (TFPR, 1985, pp.269-75). Costly and beneficial consequences (the 'production function') of DFO regulatory activities were known from experience. The problem was to set those activities at a level where the ratio of benefits to costs would be maximized. The study team concluded that the existing level of regulatory activity was too high and should be reduced: this would obviously reduce input costs (government expenditures), and - not so obviously - reduce output costs, since at existing high levels the increment of regulatory activity was not contributing to the relevant goals (the large regulatory burden was imposing excessive

compliance costs on the fishing industry, for instance). This wasteful increment could be excised without reducing the beneficial output of DFO regulation (management and conservation of the common property resource); and this benefit could be augmented by devolving some responsibility for the resource to the industry by privatization measures (such as quotas), further reducing the input and output costs of government regulation.

The B.C. government methodology for public sector rationalization, or "restraint", was rather less formalized than the federal program review procedure, but it displayed the same basic orientation, one that can be traced to neoclassical economics:

Governments everywhere have run up against the law of diminishing returns. The more expenditure grows the less each dollar adds in service to the public. It is time to reverse this process. It is time to strive for more with less. Productivity must become a central theme (MF, 1983, p.12).

Interestingly, Kesselman remarks of the B.C. government approach that it appeals to those who are "... familiar with costs, profits, and productivity in their most basic sense, that applicable to a profit oriented small business firm. They view governmental activities in very similar terms - judging each product or service by its profitability and ready to cut costs mercilessly if survival of the enterprise appears threatened" (1986, p.82). The provincial government prescription for public sector "productivity" quoted above indeed conforms with the basic neoclassical theory of the firm. In this model, firms are assumed to have known production functions, which determine the dollar values of costs and returns resulting from different levels of production. Also according to the model, production functions are characterized by diminishing marginal returns (called "the law of dimishing returns" above), and increasing marginal costs. Given the goal of profit maximization, the neoclassical prescription is to set the level of production so as to equalize costs and returns

at the margin, thereby maximizing the differential. Substitute social welfare maximization (as welfare economics prescribes) for profit maximization, and some measure of social values of costs and returns for dollar values, and the basic neoclassical model of the firm can be applied to government services. The same efficiency prescription - to set 'production' at a level where marginal benefit equals marginal cost, and thus, as in this case, to reduce output (of government services) if its marginal cost exceeds its marginal benefit - can be applied accordingly. This is precisely what seems to have been intended, ostensibly, in B.C. budgeting policy in the early 1980's. What in effect this policy meant was that those units of government service that were judged to be producing low benefits compared to costs (measured according to some common scale of social value) would be cut. The results of this policy, if less rigorously arrived at, were thus similar to those recommended by the federal task force.

The same neoclassical model of the firm - this time without adaptation for social welfare 'maximization' according to the precepts of welfare economics - can also be discerned in the notion of "self-policing", which has been prominent in salmon farming policy. In the early 1980's the idea of using market incentives to foster public goals [6] gained prominence with U.S. publications such as Charles Schultze's "The Public Use of Private Interest" (1977). Indeed even the U.S. Environmental Protection Agency at this time "continually emphasized voluntarism" as the favoured means of environmental protection, on the somewhat facile assumption that the interests of industrialists, who are private members of the community that suffers the effects of pollution, exactly coincide with the public interest in preventing it (Rhoads, 1985, p.115). In salmon farming, the reasoning was that since farmed fish are highly sensitive to pollution, it was in firms'

rational self-interest not to cause pollution, which would affect their own stock. So when, in the Gillespie Inquiry, extensive evidence of the environmental risks of salmon farming was presented, "the farm industry acknowledged these potential problems but [still] emphasized that it is in the farmer's own self-interest to mimimize such impacts to maintain a healthy growing environment for his fish" (Gillespie, 1986, p.17): impliedly, there would be no significant environmental impacts because industry would prevent them. The B.C. government apparently shared, and to some extent continues to share, this view (eg. MAF 31, 1990, p.1) [7].

On the (erroneous) assumption that all pollution caused by farms would also adversely affect their own stock, the basic neoclassical theory of the firm would make the following predictions about self-policing. Presumably the production practices that might cause 'pollution' also confer a benefit on salmon farming firms. Thus, for example, toxic TBT is a valuable (cost-reducing) antifoulant; similarly, costs in controlling fish wastes are avoided by permitting these wastes to escape into the marine environment. The theory of the firm predicts that the rational salmon farmer will use just so much of these production techniques that their marginal benefits equal their marginal costs. It also assumes that he has the information (and foresight) to make these calculations. The information on *benefits* - the avoided cost of nets' being fouled and the avoided cost of preventing waste 'emissions' in the above examples - is obvious: these costs are readily predictable effects of not using the production techniques (ie. readily predictable benefits of using them). The information on *costs* of using such techniques - such as possible, long-term effects of waste emissions on water quality, which might in the future be harmful to farmed stocks - is far more uncertain: these effects, typically, are not precisely predictable [8]. Only if these costs

were known (as the basic theory assumes they are) would farmers reduce the production techniques causing them accordingly. (Even if farmers did have accurate knowledge of all relevant costs of these techniques, not merely of their benefits, they would presumably only *eliminate* the production technique if the costs incurred were at all levels of production greater than the benefits.)

So the self-policing argument (at the very least) depends for its effectiveness on the accuracy of the assumption that salmon farmers operate under reasonable certainty, and with 'symmetrical' information, about both benefits *and* costs of production practices. Given the pervasive uncertainty about ecological effects (ie. costs) discussed in Chapter Three, this assumption is unwarranted. But it is the same as the assumption - of perfect information - used in the neoclassical theory of the firm, and may well have derived from that theory, having the same roots (as the quotations above indicate) in the neoclassical conception of 'rational self-interest', and thus, ultimately, in the characterization of *homo economicus*.

By 1989 the B.C. government had evidently come to the conclusion that self-policing depending for effectiveness on accuracy of the assumptions of complete congruence of private and public ecological costs, lack of significant private benefit from use of polluting techniques, and perfect foresight of farmers - was not a watertight method for controlling ecological impacts [9]. Accordingly, the seemingly reluctant view was now that some regulation of environmental effects was necessary:

A large, completely new industry that is dependent on common property resources cannot exist in a vacuum of government involvement. Appropriate government intervention is needed to protect the public interest.... This significant new industry needs some regulation to ensure responsible growth and development and at the same time to provide a comfort factor for groups that feel threatened and would block
further aquaculture development (MAF, 1989, p.1).

The emphasis here on implied "common property" effects and the resulting need for government regulation represents quite an about-face since 1984, when the assumption was made, "... recognizing the importance of the private property aspects of... aquaculture" (ITFA, 1984, p.20), that no such 'negative' regulation was needed (see Chapter Four). The reference to common property can also be interpreted as an invocation of the neoclassical notion of 'externalities' as rationalization for government intervention: neoclassical welfare economics recognizes that markets fail to allocate resources efficiently where there are no exclusive property rights over those resources - because they are 'common property' - and they cannot therefore command a market price. Quite simply, according to neoclassical economics, negative externalities affecting common property resources require government regulation.

### The non-adaptive neoclassical model

Underlying the pure theory of neoclassical economics and what Simon calls its "program of situational determinism" is "... 'the Great Theory' of general equilibrium economics which [one commentator] refers to as 'the Economics of Tranquillity, that is, of Confident Foresight'. Its assumptions of a stable, knowable, and foreseeable world seemed tenable as a first approximation to reality during 1871-1913 [the period of the Walrasian 'marginalist revolution' in economics] while Western Europe was at peace. The cataclysm of World War I, followed by hyperinflation... and... mass unemployment... dramatized the irreducible lack of knowledge and the impossibility of perfect foresight among human decision makers" (Fox & Miles, 1987, p. xvi). Despite the now universally recognized

importance of uncertainty in real-world decision-making, though, general equilibrium theory with its marginal identities - employing what Simon calls "static optimization under certainty" (1978, p.10) - remains at the heart of modern neoclassical economics. Alchian hints at the real-world incongruity of some of its assumptions:

Current economic analysis of economic behavior relies heavily on decisions made by rational units customarily assumed to be seeking perfectly optimal solutions. Two criteria are well known - profit maximization and utility maximization. According to these criteria, appropriate types of action are indicated by marginal or neighborhood inequalities which, if satisfied, yield an optimum. But the standard qualification usually added is that nobody is able *really* to optimize his situation according to these diagrams and concepts because of uncertainty about the position and, sometimes, even the slopes of the demand and supply functions. *Nevertheless*, the economist interprets and predicts the decisions of individuals in terms of these diagrams, since it is alleged that individuals use these concepts implicitly, if not explicitly (1950, pp.211-12; italics added).

The determination of neoclassical economists to continue to base their analyses of

economic behaviour on the assumptions of optimizing 'utility maximization' (and the perfect

foresight on which it depends), despite strong evidence of the lack of realism of these

assumptions, was vigorously defended by Milton Friedman in his influential 1953 essay,

"The Methodology of Positive Economics". On analogies with leaves that position themselves

in order to receive optimum levels of light and with an expert billiard player with

strongly-developed intuitive skills, Friedman asserted that

[i]t is only a short step from these examples to the economic hypothesis that under a wide range of circumstances individual firms behave *as if* they were seeking rationally to maximize their expected returns... and had full knowledge of the data needed to succeed in this attempt; *as if*, that is, they knew the relevant cost and demand functions, calculated marginal cost and marginal revenue from all actions open to them, and pushed each line of action to the point at which the relevant marginal cost and marginal revenue were equal. Now, of course, businessmen do not actually and literally solve the system of simultaneous equations in terms of which the mathematical economist finds it convenient to express this hypothesis, any more than

leaves or billiard players explicitly go through complicated mathematical calculations.... The billiard player, if asked how he decides where to hit the ball, may say that he just 'figures it out'...; and the businessman may well say that he prices at average cost.... The one statement is about as helpful as the other, and neither is a relevant test of the associated hypothesis.

Confidence in the maximization-of-returns hypothesis is justified by evidence of a very different character. This evidence is in part similar to that adduced on behalf of the billiard-player hypothesis [ie. that if he could not make optimal shots he would not in fact be an expert billiard player] - unless the behaviour of businessmen in some way or other approximated behaviour consistent with the maximization of returns, it seems unlikely that they would remain in business for long (quoted in Hahn & Hollis, 1979, p.32).

Though this defence of neoclassical maximizing assumptions has apparently been effective (in that they survive relatively intact in modern neoclassical analysis), it is also an extremely confusing one. Friedman uses what seems to be an evolutionary argument - 'natural' selection of 'the fittest' - to infer logically that firms *can* behave in a manner that maximizes their returns, with the same effect *as if* they were making the marginal calculations that economists make, because if firms did not do so they would not survive. How they actually, empirically make their profit-oriented calculations is irrelevant to economic theory: the neoclassical prediction that firms will act so as to maximize profits is not affected by such behavioural questions. It is a good enough assumption that firms really do act so as to maximize their profits, however it is that they actually do so.

The actual, 'evolutionary' *process* whereby firms may become adapted to the competitive economic environment is evidently of no interest to Friedman. He seems to assume that it has already taken place and that existing firms have already achieved perfect adaptation. Alchian, by contrast, takes a much closer look at the possible evolutionary process, identifying a winnowing effect whereby the economic environment "adopts" firms that happen, regardless of their own motivations or foresight, to be behaving in accordance with the changing requirements of that environment, and which therefore survive under

those conditions (1950, p.219). Firms also "adapt" to the environment by trial-and-error learning, imitation of other firms that prove successful, etc. (ibid.): they have some foresight about how to achieve their profit goals, but it is certainly not perfect (p.217). Perfect adaptation - the convergence of firm behaviour "... to a limit of 'profit maximization' equilibrium" - is very unlikely in a typical economic environment, which is characterized by change (p.219): "The economist may be pushing his luck too far in arguing that actions in response to changes in environment... will converge as a result of adaptation or adoption toward the optimum action that should have been selected, if foresight had been perfect" (p.220). Alchian thus submits a set of empirical assumptions about individual and system behaviour, on which to base aggregate predictions about the economy, that are far less unrealistic than the conventional neoclassical assumptions of optimization under certainty (ie. perfect foresight). But these assumptions - of environmental adoption and imperfect adaptation - are only suited to "... a vastly different analytical framework [from neoclassical methodology, which imitates equilibrium physics] - one which is closely akin to the theory of biological evolution. The economic counterparts of genetic heredity, mutations, and natural selection are imitation, innovation, and positive profits" (ibid.).

So though there are superficial points of conformity with Friedman's essay, there is a fundamental difference in basic methodology. And neoclassical theory has in fact decided to follow Friedman and model itself on physics rather than evolutionary biology, rejecting the process-oriented approach proposed here by Alchian [10]. As noted above, neoclassical economics is deeply committed to the deductive ideal of physics - to the use of simplifying abstractions from which to draw out logical inferences, or predictions. The simplifications facilitate the making of predictions, which Friedman sees as the main task of science; thus

the "... task [of positive economics] is to provide a system of generalizations that can be used to make correct predictions about the consequences of any change in circumstances" (1979, p.19). A (positive) science consists in part of "... a body of substantive hypotheses designed to abstract essential features of complex reality" (ibid., p.21), and "a hypothesis is important if it 'explains' much by little, that is, if it abstracts the common and crucial elements from the mass of complex and detailed circumstances surrounding the phenomena to be explained and permits valid predictions on the basis of them alone" (p.26). The deductive method and the simplification it permits thus has great pragmatic appeal:

... it is often possible to obtain predictive results based on very simple assumptions about human motivation. It is not that economists view the world in a simple-minded fashion, but rather that simplifying assumptions about human behavior allow the economist to make powerful predictive statements without becoming a victim of a quagmire of behavioral questions about human motivation which can never be effectively concluded. This... only means that for some problems the economist finds the effects of [deviations from his assumptions] on the problems at hand not significant enough to warrant special attention (Amacher, 1984, pp.165-66).

Having made the choice to use a physics model - because of its obvious advantages for prediction and control - rather than a biological or historical one, neoclassical economics committed itself to making a small number of extremely strong <u>a priori</u> assumptions from which to make deductions, which, like the laws of physics, supposedly hold universally and timelessly [11]. It was important, then, that these abstractions should be extremely judicious ones - that any deviations from them should not be "significant enough to warrant special attention" - in order for *good* predictions, not merely readily computable ones, to be derived from them. For Friedman, the neoclassical assumptions of rationality (embodied in *homo economicus*), though technically unrealistic at the individual, behavioural level - since individuals *don't* go through the marginalist, maximizing calculations that economists

make - *are* judicious, since they are realistic enough for the purposes of political economy, which makes predictions about aggregate phenomena at the level of the economy: at this level "the maximization-of-returns hypothesis" is supported (cf. Simon, 1979, pp.494-95).

For Simon, the neoclassical assumptions of perfect rationality are not 'realistic enough' to give good predictions at either the individual, behavioural *or* at the aggregate levels. Clearly, in a world where change and uncertainty are the norm - where "complexity is deep in the nature of things" (1978b, p.12) - individual economic agents can very seldom calculate an optimal solution to their problem of choice. This, though, is what the pure theory assumes:

The classical model calls for knowledge of all the alternatives that are open to choice. It calls for complete knowledge of, or ability to compute, the consequences that will follow on each of the alternatives. It calls for certainty in the decision maker's present and future evaluation of these consequences. It calls for the ability to compare consequences, no matter how diverse and heterogeneous, in terms of some consistent measure of utility (1979, p.500).

Thus "... the classical theory of the firm in its simplest form"

... assumes that there is *given*, in addition to the goal of profit maximization, a demand schedule and a cost curve. The theory then consists of a characterization of the substantively rational production decision: for example, that the production quantity is set at the level where marginal cost, calculated from the cost curve, equals marginal revenue, calculated from the demand schedule. The question of whether data are obtainable for estimating these quantities or the demand and cost functions on which they are based is outside the purview of the theory (1976, p.137; italics added).

The basic neoclassical assumptions about the individual economic agent are thus that he has the required data (which are assumed to be "given"), and can perform the necessary calculations, to achieve his maximizing goal: in the case of the entrepreneur (firm), he knows his 'production function', or the productivity of each increment of production. These assumptions are clearly inaccurate descriptions of reality: "There can no longer be any doubt that the micro assumptions of the [classical theory of the firm] - the assumptions of perfect rationality - are contrary to fact. It is not a question of approximation; they do not even remotely describe the processes that human beings use for making decisions in complex situations" (1979, p.510). Empirical evidence about real firm behaviour, for instance, has suggested "... the heretical proposition that prices are often determined by applying a fixed mark-up to average direct cost rather than equating them [and thus marginal revenue] with marginal cost" (1976, p.137). Firms may well not be able to measure the dollar costs and/or returns of each increment of production - "How could the marginal productivity of R & D expenditures be measured? Or of advertising expenditures?" (p.138). But, most fundamentally, firms will not be able to foresee what would be the marginal productivity of a given level of production in conditions of any uncertainty: as Alchian says, in reality there is thus typically "... uncertainty about the position and, sometimes, even the slopes of the demand and supply functions" (1950, p.212). In fact the abstract demand and cost functions, or 'curves', that neoclassical economists use in their maximization calculations are derived by deductive inference rather than empirical observation of individual firms: such specific functions and curves are in fact not calculable, using real data, by real-world firms, who cannot therefore make maximizing calculations on their basis. Deliberate maximization (of profits) would only be possible under complete certainty (ie. with full data) about these curves, or production functions. Given the complexity of the real world the wide range of alternatives relevant to choice and the difficulty of calculating their consequences, or, in other words, the pervasive uncertainty about present and future conditions - the maximizing 'solution' offered by neoclassical theory, based on 'given' data,

is thus highly unrealistic [12]: "A theory of rationality that does not give an account of problem solving in the face of complexity [and thus uncertainty] is sadly incomplete. It is worse than incomplete; it can be seriously misleading by providing 'solutions' to economic questions that are without operational significance" (Simon, 1978b, p.12).

The real decision-maker will in fact use what (imperfect) data or information he has to further his goals; and of course it is rational to try to improve that information - to reduce uncertainty - in order to increase success [13]. But "... classical theory was never designed to handle, and has never handled satisfactorily... decision making under uncertainty..." (Simon, 1979, p.497): with no basic recognition of uncertainty (which is regarded "... as an aberrational exogenous disturbance" (Alchian, 1950, p.221)), pure neoclassical theory, not surprisingly, contains no model for reducing it. Nor does it generally achieve an adequate treatment of process [14] - in fact Simon refers to the predictions of neoclassical theory as "process-independent" (1979, p.509). Neoclassical "... economics has largely been preoccupied with the results of rational choice rather than the process of choice" (1978b, p.2). An analogy with another area of general equilibrium theory - 'market clearing' by the equilibration of supply and demand - is informative here: "Walras [the father of equilibrium theory] resorted to a fanciful story about a 'tatonnement' process whereby some fictional 'auctioneer' would call out prices to the economic actors. The auctioneer then compares supply and demand for each good given to him by the agents in the form of tickets... and raises the price in markets with excess demand and lowers it in markets with excess supply. Only when he has stumbled upon a set that would allow the simultaneous equilibrium of supply and demand on all markets to occur, would he allow actual trades to take place" (Lawlor, 1987, p.30). This meagre fiction indicates the general

neglect of process in general equilibrium theory: though the theory has a rigidly *individualistic* basis, in the Walrasian account of "tatonnement", equilibrium is effected by some "... inexplicably *social* or structural-level concept [which]... is anthropomorphically transformed into a being of such fantastic omniscience that it resembles Hegel's ideal spirit more than rational economic man!" (ibid., pp.30-31; italics added). And in fact, in the real world "... most actual markets do not actually clear according to price" - equilibrium is never reached (Kuttner, 1985, p.76).

The process of evolutionary adaptation of firms towards profit-maximizing equilibrium at the aggregate level, cited by Friedman (as noted above) as inferential evidence to support 'the maximization-of-returns hypothesis', seems to have been treated in a similarly cavalier way. Friedman attempts to evade the reality that individual firms do not in fact make the maximizing calculations, nor possess the required knowledge of 'production functions', that theoretical economists make and possess, by claiming that businessmen (in the aggregate) do in fact maximize profits but by means other than deliberate calculation alone, such as by expert intuition - otherwise they could not remain in business. As Simon puts it, "... in economics, evolutionary arguments are often adduced to explain the persistence and survival of functional patterns, and to avoid assumptions of deliberate calculation in explaining them" (1978b, pp.3-4). Functional analysis of this kind "... is concerned with explaining how 'major social patterns operate to maintain the integration or adaptation of the larger system" (ibid., p.3). This type of analysis could support the argument that competitive selection operates to ensure that only those firms most fitted to the economic environment (most profitable, thus presumably most productive and valuable to society) in fact survive - in line with Hayekian analysis. But this does not

mean that generalized, axiomatic profit maximization can be deduced using a functional analysis. "Functional arguments are arguments about the movements of systems toward stable self-maintaining equilibria. But without further specification, there is no reason to suppose that the attained equilibria... will be global maxima or minima of some function rather than local, relative maxima or minima" (ibid., p.4). The evolutionary argument for the system as a whole does not in any way infer that *all* of its components - in this case, individual firms - achieve simultaneous 'equilibrium', or profit maximization: far from it. "Further, when the system is complex and its environment continually changing (that is, in the conditions under which biological and social evolution actually take place), there is no assurance that the system's momentary position will lie anywhere near a point of equilibrium, whether local or global" (ibid.). Thus Simon agrees with Alchian that in a (typically) changing economic environment, no single firm may achieve profit-maximizing, 'perfect adaptation' (1979, p.509) [15]. Friedman's inferential evidence that 'under a wide range of circumstances' firms do (somehow, approximately) maximize profits is therefore weak: according to a more fully-explored evolutionary analysis, some might, at some time, but probably not. (The empirical evidence for maximization is no better: for instance, psychological experiments have shown that in situations of any complexity, subjects do not act according to the objective requirements of the situation for utility maximization, even intuitively - in fact they do not act in their own precise self-interests, but are intuitively 'misled' by false patterns, etc. [16].) Simon concludes that "human behavior, even rational human behavior... is certainly not to be accounted for by assuming perfect adaptation to the environment" (ibid., p.510), even though this argument for 'selected', non-deliberate optimization has apparently been the

last line of defence for the neoclassical maximization-of-returns hypothesis, since in reality individual agents cannot deliberately make the necessary maximizing calculations.

Simon thus concludes that the assumptions of the pure theory - the assumptions of perfect rationality, including perfect foresight, which in effect Friedman defends - are not 'realistic enough' to base even aggregate predictions upon. Friedman had based his argument on the fact that the physics Law of Falling Bodies, which is derived for conditions in a vacuum, can be used to predict adequately the behaviour of falling bodies in a wide range of circumstances in the real world (where there is air pressure) (quoted in Hahn & Hollis, 1979, p.29). He notes that assumptions must always be simplifying abstractions; and assumptions should specify the conditions in which a theory holds (ibid., p.30). The Law of Falling Bodies (the physics theory) works (gives adequately accurate predictions) in idealized situations where there is a vacuum; and in real situations where there are no significant disturbing forces - where the real conditions closely approximate the ideal ones. It is not, perhaps, unfair to suggest that Friedman, in effect, reverses this chain of reasoning to support the neoclassical assumptions of perfect rationality: the economic theory (maximization-of-returns hypothesis) 'works' (gives workable predictions); therefore its idealized assumptions (of perfect rationality) 'must' - not empirically, but for analytical convenience - closely approximate real conditions. So he adduces 'evidence' largely inferential, as described above - to 'prove' that perfect rationality, though it takes a mysterious form [17], really is a close enough approximation of reality; and concludes that "... under a wide range of circumstances [ie. generally] individual firms behave as if they... had full knowledge of the data needed [ie. they approximately do]...; as if ... they knew the relevant cost and demand functions... and pushed each line of action to the point at which...

marginal cost and marginal revenue were equal" (1979, p.32). In other words, perfect rationality is a close enough approximation of reality, and the predictions based on it will be adequately accurate (not merely easy for theoreticians to make). Simon disagrees; given the fact of real-world complexity, perfect rationality is totally unrealistic in virtually all circumstances: "It is not even a question of approximation; [the assumptions of perfect rationality] do not... remotely describe [even the intuitive] processes that human beings use for making decisions in complex situations" (1979, p.510). "We cannot use the *in vacua* version of the law of falling bodies to predict the sinking of a heavy body in molasses. The predictions of the classical and neoclassical theories and the policy recommendations derived from them must be treated with the greatest caution" (ibid., p.509).

The neoclassical idealization of humanity - *homo economicus*, equipped with complete certainty about the world - is, rather obviously, not realistic, as all simplified idealizations of complex phenomena are not. But neoclassical economists like Friedman seem to have largely forgotten that the rational economic man and his attributes *are* merely idealizations, and coarse ones at that. Daly and Cobb call this neglect of the degree to which models abstract from reality, and the uncritical use of those abstractions to draw conclusions about concrete reality, 'the fallacy of misplaced concreteness', and note that it is pervasive in mainstream (neoclassical) economics (1989, p.36).

It would in principle be possible for contemporary economists to avoid neglecting the degree of abstraction involved in their models and therefore in the theories based on them. They might recognize that their theories are like the physical theory that in a vacuum, objects of differing density fall at the same speed. Physicists do not conclude from this that a stone and a feather dropped from the top of a cliff on a windy day will reach the bottom simultaneously. Physicists know that the real world is not a vacuum [ie. that in most circumstances the simplified model does not even approximate complex reality], and economists should remember that a real human being is not *Homo economicus*. But in general they forget the abstracted from dimensions of real

## people.

Our point is not that a science of "pure" economics is impossible or undesirable. Our point is that economics as a discipline does not present itself in that light with sufficient care. It enters the arena of explanation of aspects of what transpires in the real world and offers recommendations for policymakers and businessmen.... too often, in the process of doing so, it neglects the degree of abstraction involved in its concepts and arguments, and the results of its reasoning can be dangerous to public well-being when applied directly to the actual world.

Too often economics has shaped its anthropology and its theories with an eye to "analytical convenience" rather than empirical warrant. As a result, policy decisions are determined by mathematical theorems whose virtue is their deductive fruitfulness rather than their connection to the real world. The abstraction has gone too far, and the practitioners of the discipline are too little aware of it. The fallacy of misplaced concreteness is too pervasive (Daly & Cobb, 1989, pp.95-6).

By not presenting itself with sufficient care as a purely abstract science, neoclassical 'pure' theory in effect draws a veil over the difference between the ideal and the real. Deeply embedded abstract assumptions, so important for the analytical convenience of the discipline - for its ability to make usable predictions - take on the character of implicit empirical axioms. As Kuttner says, "perfect competition [which requires 'perfect information'], in a sleight of epistemological hand, is said to describe the best possible *as well as the actual world* " (1985, p.74). He elaborates: "By reasoning deductively from axioms economics confuses the normative with the descriptive. Theory stipulates, *a priori* , that perfect competition is both a description of the optimal world and a useful approximation of the actual world" (p.76). Neoclassical theory thus suggests implicitly, incredible as it may seem, that perfect information and the attributes of perfect rationality *are* generally reasonable approximations of reality.

In a world where uncertainty is commonplace this suggestion, even if it is only implicit, is obviously misleading. So not only does basic neoclassical theory contain no model of 'procedural rationality' - of the process of appropriate adaptive behaviour in the face of uncertainty; but it also contains the implication for those who would interpret it

loosely that even in situations of evident uncertainty its prescriptions can be used to good effect.

#### Neoclassical ideas in policy and planning relevant to ecological aspects of salmon farming

Efficiency, as Ehrenfeld puts it, was "originally a manufacturing concept... [and] is adequate for designing some machinery and technical processes because the systems to which it is applied are largely defined and contained.... it appears to be completely defined, completely logical and analytical. This appearance, however, has been achieved at the sacrifice of context... " (1981, pp.244-45). The social application of the idea of efficiency has been described as "... the ultimate end of technique which... 'does in the domain of the abstract what the machine did in the domain of labour'. [Commentators have] pushed the idea of efficiency beyond the machine and argued that in the guise of technique it pervades every aspect of modern society.... techique [is seen] as characteristically rational and artificial and centered on the concept of order" (Bauman, 1986, pp.20-21). Efficiency prescriptions, if they are to produce unambiguous improvements, are thus premised on a high degree of definition and predictability (order) - characteristics of the machine inherent in the systems where output:input ratios of some valued component are to be increased.

Neoclassical social efficiency calculations are based on the rational decision-making model described above: "goal selection, identification of alternatives and their consequences, and an optimizing decision" (Culhane et al., 1987, p.5). As also mentioned above, this model at its most basic level "... calls for knowledge of *all* the alternatives that are open to choice. It calls for *complete* knowledge of, or ability to compute, the consequences that will

follow on each of the alternatives. It calls for *certainty* in the decision maker's present and future evaluation of these consequences. It calls for the ability to compare consequences, no matter how diverse and heterogeneous, in terms of some *consistent* measure of utility" (Simon, 1979, p.500; italics added). These requirements, according to Simon's empirical evidence, can only be met by real decision-makers in extremely simple, artificial situations "... where the alternatives of choice are fixed in advance, and where information is available from precisely specified sources" (1976, p.143). But basic neoclassical economics, as I have argued above, presupposes that the assumptions of the rational decision-making model are reasonable approximations of reality in a wide range of circumstances. Indeed the basic neoclassical theory assumes that the data necessary for economic decision-makers to make their optimizing decisions are 'given', the implication being at least that they can acquire this information in practice. So, in the rational decision-making model, the agent merely needs to "identify" all relevant alternatives and consequences. In reality, of course, the more complex and uncertain the decision-making environment, the more unrealistic the assumption of comprehensive knowledge of all relevant present and future conditions becomes, and the more dangerous the decisions based on that assumption [18]. Likewise, the less mechanical - simple and predictable - is the relevant system, the lower is the likelihood of unequivocally successful efficiency improvements to it, because of unanticipated 'side-effects' that are neglected with the narrowing of focus required for precise efficiency calculations. According to Simon, in most real-world (ie. complex and uncertain) situations, the neoclassical optimizing techniques (which require certainty, or comprehensiveness) - including, by extension, marginalist efficiency calculations [19] - are "without operational significance" (1978b, p.12), since

the real-world decision-maker cannot acquire the necessary information. (In the case of firms, for instance, he needs to know the relevant production function - ie. have comprehensive information about all marginal productivities.) Decision-makers actually applying the rational model for efficiency calculations will, in fact, utilize what limited relevant information they have (ibid., p.378) [20], and if they are scrupulous, will treat the prescriptions derived in a manner appropriate to the recognized level of uncertainty (p.382) [21]. Given political realities, though, and the suggested 'epistemological sleight-of-hand' of neoclassical economics - its methodological implication that the rational model's simplifying assumptions, of 'perfect rationality' or certainty, are also adequate approximations of reality - there is nothing to prevent decision-makers from using these rational techniques without appending the appropriate caveat for uncertainty - "... as a drunk uses a streetlight, for support rather than illumination" (Brooks, 1989, p.84).

The first step in the rational decision-making process (and thus also in social efficiency calculations, such as program budgeting) is to fix on a goal. This action is in itself the subject of considerable controversy, even among economists, because it involves a greater or lesser degree of homogenization of the disparate and perhaps conflicting goals and values of society by a central authority; according to economists, the problem in program planning, for example - as in other areas where the rational technique is applied - is that "... there are no private markets to establish the price of the [agency's] output and [thus] to show society's valuation of the activity" (Hartley & Tisdell, 1981, p.378). In the application of the model to public sector planning relevant to salmon farming, the goals decided on were as follows. The 1984 Task Force on Program Review apparently interpreted DFO's mandate for conservation and management as being intended to contribute

to the economic efficiency of the fishery, a goal which must be pursued within tight expenditure constraints; while the B.C. "restraint" program was aimed at increasing "productivity" in all government departments. The latter goal, in particular, is an extremely vague one, providing scope for actual public sector planning decisions to be made on almost any political grounds - though the commercial metaphor does give some indication of the political orientation in this case.

The next step is to "identify" all alternatives relevant to the stated goals, and their consequences. In this 'identification' process, in real life, "pragmatic criteria" predominate (cf. Hartley & Tisdell, 1981, p.378). Measurement of some type is necessary, in order to complete the last step in the process, the required comparison of "... consequences, no matter how diverse and heterogeneous, in terms of some consistent measure of utility [goal satisfaction]" (Simon, 1979, p.500). This in itself creates a bias in social efficiency calculations against the inclusion as possible costs and benefits of effects that are not readily measurable. (Some intangibles, or effects that are in practice difficult to measure, may be included - as in the 1984 Task Force's judgment that regulation throws unspecified compliance costs onto industry - but the identification of these effects is likely to be selective and limited rather than comprehensive, since the perception of intangibles depends by definition on the judgment of the evaluator.) Of course, the most obvious 'consistent measure of social utility' with which to make calculating comparisons is monetary value - a pragmatic reality which lends a disproportional importance to monetary costs and benefits, such as government expenditures and 'products' of government services with tangible commercial results.

Perhaps the most significant characteristic of the rational model for present purposes,

though, is the assumption of certainty, or comprehensiveness, in the optimizing calculus. (Optimization, or prescription for the maximum divergence between benefits and costs, is a meaningless technique in the absence of comprehensive knowledge of what those costs and benefits are: the more significant the effect neglected, the more inaccurate and indeed nonsensical the proferred precise, maximizing 'solution'.) As argued above, 'assumptions' in neoclassical theory can double as simplifications made for pragmatic analytical purposes, and as actual empirical approximations to reality. Uncertainty, in deterministic fashion, may thus be conceived of as an 'aberrational exogenous disturbance' both in the model and in reality. Any relevant circumstance that is uncertain, or happens to have been overlooked, will not figure in the rational calculation; but more importantly, the possibility that there are relevant uncertainties may also be disregarded. A policy based on efficiency calculations, which are premised on certainty (comprehensive definition and predictability), is likely to contain a presumption against making provision to reduce uncertainty, through ongoing research and planning, for instance - a presumption against activities which have known monetary costs, and uncertain, perhaps intangible and long-term, benefits. In other words, the obvious cost of information will be recognized, but perhaps not its (less tangible) value. Thus calculated efficiency planning may ironically lead to inefficiency over time, because of neglect of uncertainties and inflexibility in responding to them. (As Holling says, an adaptive planning approach incorporating continuing learning and response to change may, for example, be "... more feasible in 'less efficient'... countries" (1978, p.37). Similarly, the market's apparently greater effectiveness than central planning at actually (efficiently) meeting society's goals, rather than merely planning analytically to do so, is apparently facilitated by its provision of a

means for gathering uncertain and often qualitative data and responding to changes in it over time, rather than by a reliance on technical methods for prediction and precise prescription by professional experts.)

The suggested methodological confusion in neoclassical economics over the notion of uncertainty also seems to have had an influence in the self-policing issue. According to Friedman, we can assume that generally, firms really do act as if they "had full knowledge of the data needed" to maximize their profits - if they did not, they could not remain in business. I have already argued that this latter inferential 'proof' demonstrates a lack of understanding of (and probably even concern with) evolutionary process. Friedman's 'definitive' neoclassical argument leaves us with the impression that firms are believed, generally, to possess a close approximation of the data needed for maximization, apparently acquired without intervention of time. In fact, of course, firms learn [22] information relevant to their costs and returns over time, and in a new industry such as salmon farming we cannot expect the many uncertainties to be learnt in a short period. The self-policing argument, though, assumes that costly ecological effects caused (and to be suffered) by farms are already known to them, in order for them rationally to minimize the actions that produce those costs. Ecological costs, of course, are typically hard to predict, which largely negates the argument: a policing regime that requires the passage of several years, perhaps, while firms learn about such costs (to themselves), before becoming effective, is hardly a flawless one. (Government technical expertise could presumably do a better job of prediction, and thus prevention of pollution, particularly since industry has an incentive to give potential 'self-pollutants', which are also presumably cost-reducing agents, the benefit of any doubt, and thus to continue to use them.) So the apparent empirical

neoclassical assumption that firms 'just have' adequate information for profit maximization (and thus cost minimization), and so 'will' instantaneously [23] ensure ecological protection, or 'maintain' optimum environmental conditions, does seem to have figured in the self-policing argument - even though its exponents recognized, contradictorily, that farmers would have to learn over time (as must have been obvious):

It is important to understand that the *maintenance* of optimum environmental conditions is necessary to a mariculturist and that all farmers by necessity will be attempting to achieve this state. Virtually all farms are maintaining a system of daily records for their own sites and attempting to get to know the year-round conditions that are influencing the health and consequent growth rates of their livestock.... It is obvious that those farmers who do not carry out this process will not be in the business very long (Gillespie I, 1986, Campbell R., p.74; italics added). [Note the Friedmanite substantiation of the argument at the end.]

By 1989, as suggested above, the now obvious failure of the self-policing argument, and the recognition that some government regulation of ecological effects was in fact necessary, led the B.C. government to rationalize its changed policy in terms that appear to invoke the neoclassical concept of 'externality'. The neoclassical (welfare economics) prescription for government intervention to redress negative externalities is based on the usual optimizing technique, using marginal calculations. The starting point is to "imagine that the marginal... external cost [to society] imposed by the emission of a pollutant from an industry is a function of the total level of emission by the industry" (Hartley & Tisdell, 1981, p.156). Then "... the socially optimal level of pollution is... where the [private] marginal costs of controlling emissions equal the [social] marginal costs of spillovers" (ibid.). All that is required is specification of the production functions which determine how private costs of control (benefits of not controlling pollution), and social costs from pollution, vary with different levels of emission, and the government can then impose a per unit tax on emissions to ensure that private marginal costs, newly imposed in the form of the tax, are the same as social marginal costs. (This is a typical profit maximizing 'solution', ensuring that private marginal benefits equal private marginal costs, and so giving firms a strong profit-motivated incentive to reduce emissions.) The theory assumes that the production functions (costs and benefits of different levels of emission) - or in geometrical terms the marginal benefit and cost 'curves' - are known, or 'given' data. In reality, the private costs of control (private benefits from pollution) at different levels of emission *may* be quite well-known; but given typical ecological uncertainty, the social costs will not be. A (marginal) social cost 'curve' is then impossible to specify. Without this specification, the neoclassical 'optimal solution' is rendered meaningless. Though neoclassical economics offers a precise policy prescription on the assumption that the necessary information is 'given', it offers no guidance on how this information is to be acquired, and indeed merely *assumes* that it can be. As Simon puts it, in the case of automobile emissions:

What decision-making procedure is rational when the basic quantities for making marginal comparisons are simply not known?... It is easy... to conceptualize the problem. There is a production function... that associates different [industry] costs with different levels of emissions. The laws governing the chemistry of the atmosphere determine the concentrations of polluting substances in the air as a function of the level of emissions. Biomedical science tells us what effects on life and health can be expected from various concentrations of pollutants. All we need to do is attach a price tag to life and health, and we can calculate the optimum level of pollution control.

There is only one hitch.... None of the relevant parameters of the various "production functions" are known - except, within half an order of magnitude, the [private] cost of reducing the emissions themselves. The physics and chemistry of the atmosphere present a series of unsolved problems.... Medical science is barely able to detect that there *are* health effects from pollutants, much less measure how large these effects are.... [more] research won't give us clear answers [in the foreseeable future] either. What constitutes procedural rationality in such circumstances? (1978b, pp.13-14).

The externality prescription - for government intervention to ensure that industry emits the 'optimal' level of pollution - is an example of what Simon means when he asserts that standard neoclassical economics "... can be seriously misleading by providing 'solutions' to economic questions that are without operational significance" (ibid., p.12). The theory concentrates on problem solution under certainty, and neglects the prior process of information acquisition under uncertainty which is a prerequisite for that solution (and may never be complete enough to permit one). The neoclassical rational model is "a theory of rationality that does not give an account of problem solving in the face of complexity" (ibid.). Neoclassical economics, in other words, has no theory of procedural rationality. The neoclassical externality prescription probably cannot be said to have had a formative, or causative, influence on salmon farming policy - merely rationalizing decisions taken on other, complex grounds. But a policy *rationalized* in terms of neoclassical externalities in other words, on the presumption of certainty about ecological effects - is itself unlikely to have demonstrated many of the characteristics of procedural rationality, or appropriate adaptive behaviour. The next section explores this implication in more detail.

# Procedural rationality" in government policy and planning relevant to ecological aspects of salmon farming

My criteria for "procedural rationality" in government policy - for an 'appropriate adaptive policy in ecological terms' - were introduced in Chapter One. The requirements set out there were *search* for (uncertain) information relevant to a major social goal affected by the activity that is the subject of policy; *insurance* of some kind to mitigate risks taken under uncertainty; and *feedback*, or effective response, to new information acquired. When the constraint of severe limits on government spending was added, to correspond to the realities of recession in the early 1980's in particular and, more generally, to the opportunity cost insight of economics, these criteria became minimal ones: lack of bias toward any category of relevant information, lack of denial of risks, and timely discharge of the relevant social responsibility (ecological protection). Government policy towards salmon farming, I shall indicate below, fell short of each of these requirements; and in fact the two patterns in policy that emerge most strikingly are an apparent emphasis on commercial concerns and an accompanying deterministic mentality.

In the preceding sections I tried to establish what I have called the 'neoclassical' influence on government policy, as a heuristic device to provide some coherent explanation of government rationalizations, to achieve some necessary simplification in the face of considerable complexity, and to indicate instructive, rather than exhaustive, avenues for analysis of heterogeneous policy. The first area of neoclassical influence suggested above was in efficiency calculations for the public sector. Efficiency calculations do seem to have had a *formative*, or causative, influence on relevant policy outcomes, affecting levels of ecological research and planning by government. These calculations, I argued, are premised on an assumption of comprehensiveness and relative certainty, and are moulded by the practical requirements of measurement. They also require the specification of some goal or category of goals which are to be achieved more effectively; and these goals, in both the federal and the provincial initiatives outlined above, were apparently fairly narrow economic, or even solely commercial, ones. The 'restraint' initiatives would therefore, in part because of the logic and practice of calculating efficiency, and in part because of the goals specified, mean making little provision for government services that had no obvious

dollar benefits and/or that had only uncertain or indirect benefits. Research into, and planning for, public ecological effects - which in salmon farming have been characterized by uncertainty - would produce no obvious commercial returns and few direct, certain benefits, so would fit into both of these categories.

As a result of the federal public sector efficiency initiatives and spending cuts of the early 1980's, DFO "... had its budget slashed by more than \$100 million" in 1984-5 (The Fisherman, 16/8/'85). The remaining resources devoted to the agency would be allocated, following the logic of the rational model discussed above, to DFO services with the highest 'marginal productivities' (to pursue the economics metaphor). Not surprisingly, then, the DFO allocations for salmon farming services apparently favoured commercial criteria for 'efficiency'. So there was considerable investment in industry development: "In the year ending March 1985, the department spent \$2.5 million on aquaculture research... focussing particularly on research and experimental development, the protection of fish from communicable diseases and the transfer and application of research results to industry" (ibid., 18/7/'86). But funding for DFO ecological (ie. non-commercial) regulation and research in salmon farming was evidently much less generous. For example, in the Gillespie Inquiry, "federal agencies lamented the fact that... the lack of manpower... reduced the frequency of periodic checks of toxicant levels in farm fish", which would have disclosed the use of such toxicants in the marine environment (Gillespie, 1986, p.18). The imbalance led the federal Standing Committee on Fisheries and Oceans (1988) to recommend that DFO "reorient" its research activities: "... new funds must be made available to increase R&D efforts in the following areas: (a) research in support of regulatory requirements..." specifically disease control (for both farmed and wild stocks), prevention of environmental

impact on habitat and water quality, and protection of human health from any farmed fish residues (SCFO, 1988, p.57). (Research solely for the industry's benefit should also be increased (ibid.), but this was given a lower priority in the order of recommendations.)

The pattern was similar at the provincial level. Up to 1986, the Marine Resources Branch (MRB) of ME - through its role as lead agency in the MFL referral system, as primary substantive administrator of production plans, and as enforcer of "diligent use" had principal effective jurisdiction (of the various provincial agencies involved) over any ecological effects of salmon farming production. (Other branches of ME, such as Water and Waste Management, did not begin to play a significant role in regulation of ecological effects of production until recommendations following the Gillespie Report, such as the 1988 Aquaculture Waste Control Regulation, came into effect.) In 1986, with provincial restraint policies in effect, MRB was downgraded to a Section with a staff of only five, and its budget cut by sixty percent (The Fisherman, 23/6/'86a) [24]. Staff admitted that there were insufficient resources for ecological research and planning (ibid., 18/4/'86b), or for "diligent use" inspection: "... that requires more people and more money so we're all between a rock and a hard place" (ibid., 23/6/'86b). In fact MRB, and indeed the provincial government agencies involved with salmon farming production as a whole, had been confined to an almost exclusively industry-supporting role. Thus the Gillespie Report recommended "... a shift in the regulation process towards provision of environmental safeguards..." (Gillespie, 1986, p.48):

The Inquiry believes the involvement of government in finfish aquaculture is more appropriately directed to the protection and proper management of *public* resources, rather than to *private* businesses and privately-owned fish.... [A shift] is needed to return the government focus to resource management.... [Biophysical s]ite characteristics, locational information, [etc.] should constitute the main elements of

the plan for site management (ibid., pp.45-46; italics added).

Corresponding to this commercial orientation of government, and with what I have argued is the tendency in calculations of efficiency to ignore uncertainties, there had been an almost complete neglect of ecological research (which has certain costs but uncertain benefits): "Research needs have been identified in almost every specific area of environmental concern addressed by this report. Staff and funding levels in government have not kept pace with the growth of the industry" (p. 39). Indeed information-gathering *priorities* - research areas which had been most seriously neglected - were in addressing particularly uncertain ecological effects, such as cumulative and long-term impacts:

The provincial government should increase its support for research and studies on the potential long-term effects of salmon farming on the marine biological and physical environment.... In particular, studies should be performed on the effects of fish farms on shellfish and other bottom dwellers, and on water quality....

The... government should establish a mandatory environmental monitoring and data gathering system.... Environmental monitoring represents a major deficiency in the regulation of finfish aquaculture.... Monitoring of on and near-site environmental conditions should become a standard requirement of aquaculture tenures, with the measurements to be recorded and regularly submitted for government review.... This data will be of value in studies of long-term environmental changes... (p.36).

In other words, the procedural rationality requirement of search - for information relevant to the social goal of ecological protection - was seriously neglected in early salmon farming policy. Without this research to redress pervasive ecological uncertainties, there could be no appropriate *regulation* of harmful ecological effects. The level of government research was increased markedly after the Gillespie Inquiry [25], following the formal acknowledgement of public concerns and acceptance of evidence detailing ecological risks (much of it also provided by the public). But in the preceding period, when the direction for salmon farming development was being set - and during which any policy was

determined entirely by government analysis - there had apparently been a systematic bias, resulting most obviously from the government 'efficiency' initiatives and the negligent pro-market assumptions discussed in Chapter Four, against the acquisition of ecological information.

This judgment might seem to be a hindsight one: it might be argued that it is easy to point out deficiencies in ecological 'search' after the event, but at the time of the industry's developmental 'take-off' there was no inkling that salmon farming might have ecological costs; extensive research on the off-chance of finding an ecological problem would have been extremely wasteful of very limited resources. In fact, though, ecological problems were anticipable from very early on, if not precisely predictable - which is the nature of many ecological effects, as I argued in Chapters One and Three. The prevailing government attitude went beyond mere passive neglect, and verged on active denial of known risks. First, it is obvious that a major technological intrusion, such as salmon farming, into an undeveloped environment is likely to have ecological repercussions; and second, a stream of evidence about ecological risks - little of it, inevitably, conclusive - was presented to government from early in the development.

As early as 1984, the B.C. Fishermen's Union (UFAWU) voiced fears about the introduction of disease to wild salmon stocks from Atlantic salmon imports, cited the much more cautious approach to salmon farming in Alaska, and called for a moratorium on B.C. development to examine possible ecological problems (amongst other concerns) (The Fisherman, 16/8/'85). In 1985, additional public concerns were expressed about possible marine pollution and potentials for genetic impacts on wild stocks (ibid., 12/12/'85). By early 1986, in addition to the reservations about Atlantic salmon imports, public fears

were being articulated about sedimentation, antibiotics and antifoulants (ibid., 18/4/'86b). Most of these public concerns, prior to the moratorium on salmon farm licence issuance in November 1986 precipitated by pressure from UFAWU, "... were discounted, and even ridiculed", according to the Union's submission to the resulting Gillespie Inquiry (Gillespie I, 1986, Parksville, p.79). The Report apparently agreed that the public had been largely ignored and recommended that MFL "... reduce the discretion available in selecting interest groups to participate in its referral process and establish a broader list... [to] include commercial fishery groups, [etc.].... The time available for meaningful comment on applications should also be extended" (Gillespie, 1986, p.43).

But perhaps the most striking evidence about the prevailing provincial government attitude towards information about ecological risks up to the Inquiry is provided by the contrast between the submission by MAF (formerly MRB) - the agency with primary effective jurisdiction over ecological aspects apart from importation problems, in the absence of a significant role for ME at this time - and the submissions of other agencies with environmental concerns, but little effective jurisdiction. On the issue of water quality effects, for example, MAF asserted that "eutrophication" was "... well understood by the scientific community to the point of being predictable..." (Gillespie III, 1986, MAF, App. E, p.1). Further, the agency emphasized that "we have not yet reached [a salmon farming situation with measurable water quality effects] in British Columbia and will not likely do so" (ibid.). Confidence was expressed in "... a computer simulation model that will enable us to forecast the 'safe limits' of production in Sechelt Inlet" (ibid., p.2). By contrast, federal Environment Canada noted "the *potential* for... impacts on water quality...", primarily from poorly sited farms (Gillespie III, 1986, EC, p.3), and agreed with a Washington study that

predictive models of fish farm impacts were, "... at best, only in the preliminary stages of development and, in general, [had] not been tested. This lack of information necessitates a cautious approach to fish farm siting" (ibid., p.4) - precisely what had been lacking in B.C. policy (see Chapter Four). On the question of disease transmission to wild stocks, MAF asked itself whether farmed native stocks could pose any threat and concluded that "in all probability the answer to this question is an emphatic 'NO'" (MAF App. E, p.2). Rather more carefully, ME assessed that "the greatest single threat to [fisheries] from the developing salmon farming industry is the accidental introduction of new diseases with the import of [European stocks], or specific races of native species such as chinook salmon from... many Pacific Northwest sources" (Gillespie III, 1986, ME, pp.3-4). ME added that it had subsidiary "concerns" about competitive and genetic effects of escaped farmed fish on wild ones (pp.4-5); MAF considered genetic problems "highly improbable" (MAF, App. E, p.5). In fact it is fair to conclude that in every area of ecological uncertainty and genuine controversy addressed by MAF, a consistently one-sided judgment was made that there was insufficient evidence for concern or to prompt additional government regulation. In view of the paucity (described above) of B.C. research to address these uncertainties up to that time, this attitude verged on what, in legal terms, would be termed recklessness [26]. It certainly does not represent Holling's 'selective risk-taking': the admission of typical ecological uncertainty - recognition of present ignorance and the unlikelihood of precise future prediction - and the resulting respect for all pertinent, though inconclusive, evidence.

There is some evidence, also, of what I am labelling a 'deterministic' attitude - the consistent effective denial of uncertainty - in government policy towards Atlantic salmon

imports. This evidence is rather less striking, though, because most of the risks *were* appreciated from early in the development of salmon farming. These risks consisted primarily of the possibility that exotic pathogens brought in with the Atlantic salmon eggs might escape into the wild, and of the extremely damaging consequences if one of these pathogens, particularly a highly-communicable one, did so and infected wild, non-immune stocks. From the beginning of the Atlantic imports in 1984-5, DFO regulations, in recognition of the risks, were extremely stringent (<u>The Fisherman</u>, 16/8/'85). By November 1985, "... DFO and the provincial government [were] discussing a policy which would dramatically curb the importation..." (ibid., 18/11/'85). In early 1986 it was reported that "the federal and provincial governments are considering a policy to end mass imports of Atlantic salmon eggs - but only in 1989, when commercial salmon farm requirements are met" (ibid., 21/5/'86).

In fact there is evidence that though all involved agencies acknowledged the basic risk, there was disagreement about its *degree*, and therefore about the speed with which such imports should be ended. In early 1986 the DFO aquaculture co-ordinator said of the government sampling procedure to check eggs for diseases, that "we're fully confident in the quarantine procedure, but it's like a lottery. The odds are high, but if you do it long enough, you'll win" (ibid.): the statistical risks of the detection procedure failing, though minute in any one case, were compounded to significant levels over time. Also in early 1986, public groups presented evidence "... that eggs certified as disease-free at [a Scottish hatchery which had already supplied a Vancouver Island salmon farm] were responsible for an outbreak of furunculosis... at 28 fish farms" in Norway (ibid., 18/4/'86a). In other words, despite stringent regulations, an exotic disease had been exported to a foreign

environment from what was considered in B.C. to be a 'disease-free facility'. Recognizing that even the most stringent regulations are not foolproof, ME recommended at the December 1986 Gillespie Inquiry that imports be reduced to 100,000 eggs by April 1987, and ended by April 1989 (Gillespie III, 1986, ME, p.4). The Gillespie Report itself judged that the risk to wild stocks "... exists despite the severe screening, quarantine and effluent treatment standards imposed by government..." and recommended an end to importations, apart from occasional small volumes for genetic improvement, by fall 1987 (Gillespie, 1986, p.37). In 1986 the Canadian Atlantic Fisheries Scientific Advisory Committee added a concern about "non-certifiable diseases":

Although the Canadian FHPR [*Fish Health Protection Regulations*] are considered among the best fish disease control mechanisms in the world, they are not infallible, a fact which along with the large number of potential pathogenic organisms that are not considered under the.... FHPR (the non-certifiable organisms) makes the likelihood of an unwanted pathogen or strain of pathogen entering the country with fish from a... FHPR certified source a very real possibility.... it therefore seems unreasonable to risk the importation of a problem that may not be detectable prior to importation to a new environment where conditions may be ideal for the disease's expression (NASCO, 1987, pp.44-5).[27]

In contrast to all these misgivings, MAF, in its submission to the Gillespie Inquiry, again displayed a more self-satisfied attitude. It reached the technical conclusion that "... the screening process has a 0.0006 percent probability of not detecting a disease", and the more evaluative one that "this is clearly a manageable risk" (Gillespie III, 1986, MAF, Appx. E, p.3). And indeed, despite the variety of opinions ranged against it, the optimistic MAF bias seems to have prevailed. There is no doubt that the importation of Atlantic stock benefits the industry: "it could allow the industry to expand as quickly as possible; it could be cheaper than purchasing local seedstocks; [etc.]..." (NASCO, 1987, p.44). Atlantic salmon have been 'domesticated' longer and are generally easier to 'produce' than Pacific stocks, and their production is common in B.C. salmon farming in 1991. At the 1986 Gillespie Inquiry, ME noted that "... there is pressure to continue the importation of Atlantic salmon eggs by some companies who have a familiarity with farming this species in Europe" (Gillespie III, 1986, ME, p.4). Reading the very legible implication between the lines [28], that pressure seems to have prevailed over the overwhelming balance of agency and informed public opinion: in 1990, for instance, a substantial number of Atlantic salmon eggs were still being imported into B.C. (300,000, compared with the initial 2.5 million in 1984-5), though for broodstock purposes only and under even tighter controls (Ron Ginetz, DFO, pers. comm., 1/2/'91). The existence of an industry black market in unregistered imported eggs was also a strong possibility in 1991 (ibid.). The latter possibility re-emphasizes the fact that even the tightest controls are not infallible, and by concentrating on the security and certainty of control, government has distracted attention from the strong consensus that imports, and the machinery on which they depend, should be discontinued.

This delay in response to what the weight of evidence now suggests is accurate information infringes the third requirement for procedural rationality, that there should be timely government 'feedback' to subsequently resolved uncertainties. Though few ecological uncertainties about salmon farming have been definitively resolved, the two areas where risks have perhaps been most conclusively demonstrated - disease transfer from Atlantic salmon imports, and toxic effects of TBT - have been characterized by delayed regulation, as argued here and in Chapter Four.

#### Conclusion

The aim of this thesis has been to identify ecologically-relevant government policy, and to judge that policy against criteria of procedural rationality, or 'appropriate adaptiveness in ecological terms'. The focus of analysis has been on the early period of salmon farming development, which I called the 'planning stage' for the industry - the period before major 'corrections' resulting from increased trial-and-error experience and social interaction had taken place, when policy was based most exclusively on cognitive, or reasoning, models necessary for prescribing future action. This phase was important in establishing the general direction that the development would take, and in setting in train irrevocable courses of events. At this early stage, as I observed in Chapter Four, there was a deliberate and marked paucity of government regulation of what over the course of time have been revealed to be ecological risks - no significant siting restrictions up to and immediately following the Gillespie Inquiry, during which time the majority of B.C. farms were approved, and few or no restrictions on farm operations with potential ecological costs until implementation of the Gillespie recommendations (such as the Aquaculture Waste *Control Regulation* in December 1988). This delay in regulation infringed the requirements for procedurally rational policy outcomes. And the delay was itself based largely on the deficiency of government ecological research and monitoring noted in the present chapter. This failure to search also infringes the requirements for policy outcomes, even in the context of tight government spending limits: even though extensive ecological information-gathering of the type required by comprehensive planning would not have been possible under these constraints, nor cost-effective, the complete omission of ecological search, when significant sums were being spent on commercially-oriented R&D,

constitutes an inadequate fulfilment of government's responsibilities for social welfare.

But I am not restricting my evaluation to policy outcomes - observable, deliberate government actions and omissions. Bartlett suggests that "in the sense of 'cognitive processes and procedures used to choose action', [Simon's] notion of procedural rationality broadly construed has particular relevance to public policy making" (1986, p.226). That is especially so in the present case, because the 'correct' policy outcomes, such as appropriate government regulation, can be judged only to a limited extent given the continuing uncertainty about negative ecological effects. (Since we still do not know whether many salmon farm introductions into the marine environment cause negative ecological effects, we still do not know if they should be regulated.) Evaluative and prescriptive criteria must, where uncertainty prevails, be predominantly procedural ones [29]. Relevant procedural characteristics in the present case include the thought-processes resulting from the cognitive models that were particularly important during the early stage of salmon farming. These reasoning processes can be evaluated by assessing the derived policy arguments that I have identified. And in the present chapter I have attempted to delineate a common theme of 'determinism' in government policy arguments.

The 'determinism' identified takes the form of a *presumption*, irrespective of empirical evidence, that sufficient data are known to make precise predictions and prescriptions. This is not the philosophical form of determinism, closely associated with the science of physics, which merely claims that nature is everywhere subject to causal law, but the *emphasis* that (I have suggested) derives from it on man's ability to predict and control - a capacity which can in fact only be realized given knowledge of all relevant

present conditions and functional relationships. The rational model of neoclassical economics presumes these data are 'given' to decision-makers [30]; following Simon, I have argued that in reality, where people *learn* information over time, it is not generally the case that they are ever fully informed - thus the model's assumptions of perfect rationality "... do not even remotely describe the processes that human beings use for making decisions in complex situations" (1979, p.510). If that is true at the level of the individual economic agent, it is doubly so at the far more complex level of government planning (such as in public sector efficiency calculations). In similar vein, Holling claims that "... however intensively and extensively data are collected, however much we know of how the system functions, the domain of our knowledge of specific ecological and social systems is small when compared to that of our ignorance" (1978, p.7). Thus in environmental assessment, "attempting to close the gap on imperfect predictions detracts from a proper focus on the consequences of the inherent uncertainties that will always remain" (ibid., p.133). But in government analysis of ecological impacts in the present case, the opinion that apparently prevailed at least up until the Gillespie Inquiry was that sufficient data were known to make precise predictions, and that since no impacts had been precisely predicted, none would occur. Clearly this opinion was not justified given the paucity of data that were actually known and the complexity of the relevant ecological environment.

If the 'popular' determinism evidenced in this case - the apparent conviction that there is no relevant uncertainty about present and future conditions - is so far removed from reality, why did its exponents make the presumptions described? Lindblom and Cohen argue that social science may be "... no more than window dressing for policy strategies chosen on

other grounds... [or may] only marginally strengthen or refine policy-making frameworks chosen on practical grounds..." (1977, p.77). In the present case I am suggesting that a (loosely interpreted) methodological principle common to the social science of neoclassical economics and the natural science of physics (where it is more appropriate to the subject-matter studied) was utilized for these same legitimizing purposes. For if there is no (admitted) uncertainty about ecological effects, then there is no need to redress that uncertainty, so costly government information-gathering and inconvenient restrictions on private industry can be avoided. If there is no uncertainty about what costs and benefits result, and will result, from government services, then the 'correct', or efficient, means to given social ends can be calculated (using what data actually are available). It happens that most of the data available are those quantifiable in dollars and having direct, material effects, so that efficiency calculations will favour commercially-oriented services. Determinism was therefore useful "window-dressing" for a government with what Kesselman calls a "mini-efficiency" approach to policy, designed primarily to aid business - a government entertaining "... the view... that policies favourable to the business sector must necessarily be economically desirable" (1986, p.81).

It is not the suggestion that a deterministic attitude was the, or even a, 'cause' of government policy decisions, but merely that it was used pervasively to rationalize policy formulations with multiple causes, not least of which was an apparent intention to aid business. The identification of a deterministic pattern provides some coherence for policy analysis, while respecting the multi-causal complexity of government policy, and permits effective response to the normative questions of the thesis, which were put in terms of procedural rationality. A deterministic attitude that denies or minimizes uncertainty also
denies or minimizes ecological risks, since these are typically, and in this case have been almost exclusively, uncertain. This attitude, or reasoning model, was therefore biased, and the policy employing it procedurally irrational.

### <u>Notes</u>

[1] I will analyse neoclassical theory, and its ecologically adaptive characteristics, more fully below.

[2] Hayek refers to the application to social phenomena of the methods of the physical sciences as 'scientism', which has negative academic and policy effects: "It seems to me that many of the current disputes with regard to both economic theory and economic policy have their common origin in a misconception about the nature of the economic problem of society [which is one of adaptation to changes in the particular circumstances of time and place]. This misconception in turn is due to an erroneous transfer to social phenomena of the habits of thought we have developed in dealing with the phenomena of nature" (Nishiyama & Leube, 1984, p.212). The "... failure of the economists to guide policy more successfully is closely connected with their propensity to imitate as closely as possible the procedures of the brilliantly successful physical sciences - an attempt which in our field may lead to outright error" (ibid., p.266).

[3] The rationality imputed to the 'rational economic man' allows neoclassical economics to model economic systems and to make strong predictions about how they would function if real-world decision-makers conformed in the relevant respects to the abstraction: as "Charles Schultze,... a recent president of the AEA, says, 'When you dig deep down, economists are scared to death of being sociologists. The one great thing we have going for us is the premise that individuals act rationally in trying to satisfy their preferences. That is an incredibly powerful tool, because you can model it" (Kuttner, 1985, p.76). (Whether the abstraction does accurately describe real-world decision-making, and indeed whether it matters, is the source of considerable controversy, however, as explained below.)

[4] The neoclassical 'economics of information' is a refinement on the pure theory in that it recognizes that the economic decision-maker is *not* automatically fully-informed about all the alternatives relevant to his choice, and so must search for them. However, this information-gathering requirement is merely represented as a cost to the decision-maker imposed by his environment, not as a limitation on his own rationality: he is still assumed to *maximize* his utility by equating costs and benefits at the margin. "In [this] optimizing model, the correct point of termination is found by equating the marginal cost of search with the... marginal improvement in the set of alternatives.... search becomes just another factor of production, and investment in search is determined by the same marginal principle as investment in any other factor" (Simon, 1978b, p.10). The decision-maker is still assumed to know exactly when to cease searching so that the beneficial consequences of search maximally exceed its costs - which requires 'heroic' foresight and calculating abilities (see below).

[5] Planning of the DFO regulatory program for the whole fishery - mainly wild stocks - is described here, because salmon farming (to the extent that DFO had jurisdiction over it) fell under this *general* fisheries regulatory policy.

[6] I have already discussed this notion briefly in Chapter Four. The idea was that since farmed salmon are sensitive to pollution, salmon farmers would have a (private) *incentive* not to pollute their (public) environments. It was pointed out that reliance on incentives alone, given that real-world firms exhibit less than perfectly rational

behaviour, is an extremely precarious form of regulation of ecological effects, even assuming that all ecological effects *of* salmon farms also affect the farms themselves (which is a false assumption). I shall expand on these conclusions, and relate them more clearly to neoclassical determinism, in the present chapter.

[7] The provincial government still emphasizes the industry's interest in environmental protection, the implication being that it can be relied on to protect this interest to a considerable extent: "Aquaculture industries rely on a high quality environment for both seafood production and marketing. Environmental deterioration often increases production costs and decreases survival and feed conversion efficiencies. These disbenefits can quickly make a competitive seafood industry non-viable. This industry also wishes to promote the image of British Columbia's pristine coastal waters as an essential component in the production of seafood products" (MAF 31, 1990, p.1).

[8] For instance, it is now believed that very small increases in nutrient concentrations (such as those emanating from fish farms), combined with other favourable conditions such as high water temperatures, can trigger harmful plankton effects, which may cause increased incidence of disease in farmed stock even in the absence of a major fish-killing 'bloom' (Ted Haughton, ME, pers. comm., 25/1/'91).

[9] As a MAF representative tersely put it: "It's been stated, and it's stated in a relatively facile manner, that fish farming requires clean water. To a certain degree it is self-policing with respect to maintaining environmental quality. Self-policing doesn't work in many areas and therefore there are regulations that are in place to maintain water quality" (NWPS, 1989, p.23).

[10] "The evolutionary or historical character of the economy has never been denied or wholly ignored.... Alfred Marshall, the founder of neoclassical economics, was highly sensitive to the historical character of the actual economy. Nevertheless, economists on the whole wanted economics to become increasingly scientific, and their idea of science was based on physics rather than evolutionary biology. That meant that economics had to focus on formulating models and finding laws 'governing' present economic behavior rather than seeking laws 'governing' the changes of economic systems or asking about contingent historical matters. As a result, when useful models have been found and when hypotheses have proved successful, they are treated as analogous to the models and hypotheses of the physicist" (Daly & Cobb, 1989, p.30).

[11] "The science of human action that strives for universally valid knowledge is the theoretical system whose hitherto best elaborated branch is economics. In all of its branches this science is *a priori*, not empirical. Like logic and mathematics, it is not derived from experience; it is prior to experience. It is, as it were, the logic of action and deed.... Our science..., disregarding the accidental, considers only the essential. Its goal is the comprehension of the universal, and its procedure is formal and axiomatic. It views action and the conditions under which action takes place not in their concrete form, as we encounter them in everyday life, nor in their actual setting, as we view them in each of the sciences of nature and of history, but as formal constructions that enable us to grasp the patterns of human action in their purity" (Von Mises; quoted in Hahn & Hollis, 1979, p.61).

[12] "The simple notion of maximizing utility or profit [can] not be applied to situations where the optimum action depend[s] on uncertain environmental events, or upon the [unpredictable] actions of other rational agents (for example, imperfect competition)" (Simon, 1978b, p.9).

[13] "We are concerned with how men behave rationally in a world where they are often unable to predict the relevant future with accuracy. In such a world, their ignorance of the future prevents them from behaving in a substantively rational manner [ie. in a manner that conforms to the objectively best solution, as known only to some omniscient observer]; they can only adopt a rational choice procedure, including a rational procedure for forecasting or otherwise adapting to the future" (Simon, 1976, p.142).

[14] It is arguable that the two major failings of neoclassical general equilibrium theory in general "... are the lack of an adequate dynamic underpinning to explain the process by which... general equilibrium... will be arrived at and maintained, and the general neglect of the knowledge assumptions necessary for such an equilibrium" (Lawlor, 1987, p.30). Thus the *process* of *reducing uncertainty* (learning) is largely neglected in neoclassical theory: for example, as neo-Austrian Israel Kirzner writes, "... 'instead of... appreciating the subtle processes of spontaneous learning made possible by market interaction under imperfect knowledge,... new work seeks to address the problems [ie. lack of an adequate neoclassical theory of market process] by constructing ever more complicated equilibrium models," (Kuttner, 1985, p.83).

[15] "... a number of [newer theories of the firm, which do not use classical assumptions] assume that organizational learning takes place, so that if the environment were stationary for a sufficient length of time, the system equilibrium would approach closer and closer to the classical profit-maximizing equilibrium. Of course they generally also assume that the environmental disturbances will generally be large enough to prevent the classical solution from being an adequate approximation to the actual behavior" (Simon, 1979, p.509).

[16] "It is not that people do not go through the calculations that would be required to reach the [utility maximizing] decision - neoclassical thought has never claimed that they did. What has been shown is that they do not even behave *as if* they had carried out those calculations, and that result is a direct refutation of the neoclassical assumptions" (Simon, 1979, p.507).

[17] Friedman suggests that the actual form of (approximately) perfectly rational profit-maximizing behaviour must "in some way or other" approximate behaviour consistent with the maximization of returns. "Let the apparent immediate determinant of business behaviour be anything at all - habitual reaction, random chance, or whatnot" (Hahn & Hollis, 1979, p.32).

[18] Supporters of Hayek call the rationalist belief that all (ie. comprehensive) present and future data relevant to social planning, such as social efficiency calculation, can be known to a 'single mind', such as a centralized government body, "the synoptic illusion":

... the domination of economic orthodoxy by the synoptic fallacy has bred a wrong view of economic policy, in which it is imagined that the only problem is that of achieving known ends on the basis of given data with the least possible expenditure [ie. that the problem is one of calculating social efficiency].... It is only on account of the pervasiveness of the synoptic illusion that we can explain the extraordinarily popular delusion that social and political problems might be liable to a 'technological' solution conceived in terms borrowed from engineering (Gray, 1984, pp.30-31).

[19] The neoclassical welfare economics prescription for efficiency in, for example, the public sector is that "in principle, the optimum size of the public sector is achieved

when, at the margin, the expected benefits and costs of additional state intervention are equal" (Hartley & Tisdell, 1981, p.367).

[20] In a representative case of program budgeting, for example, economists admit that "predictably, various pragmatic criteria have been used to determine a nation's optimum defence expenditure [ie. optimum size of a public sector agency]" (Hartley & Tisdell, 1981, p.378).

[21] Given the measurement uncertainties and other data collection difficulties in program budgeting, for instance, economists may accept that it "... is no more than a useful technique for stimulating clearer thinking about the aims, costs, and performance of a government department. It generates the type of information which is required for efficiency in government decision-making.... But individuals are still required to make decisions about the optimum size of a budget" (Hartley & Tisdell, 1981, p.382) - in other words, 'optimization' is still very much a judgment call.

[22] The question of how firms actually acquire information relevant to their goals, or learn, is a 'behaviourist' one and as such, according to Simon, has been placed "outside the Pale" of standard neoclassical economics, which is not concerned with such "microphenomena" since they supposedly do not affect predictions at the aggregate level of the economy, which is the exclusive concern of the discipline (Simon, 1979, p.494).

[23] The confusion of tenses here may be the product of the requirement by neoclassical economics that it reason deductively from universal and *timeless* axioms: it is a science, I have suggested above, without an evolutionary or historical theory, or an adequate conception of process.

[24] This was in spite of the doubling of operating salmon farms between 1985 and 1986, from 40 to 80 (see Chapter Three).

[25] For example, the Inquiry recommended that the successor to MRB, the Aquaculture and Commercial Fisheries Branch of MAF, "... reallocate its aquaculture resources to satisfy ever-increasing needs for extension services..., information to the public, and research support to both industry and environmental monitoring agencies..." (Gillespie, 1986, pp.49-50).

[26] Indeed subsequent, more detailed, research on ecological uncertainties has revealed some unexpected risks - such as the possible spread of drug *resistance* from bacteria selected by antibiotic use to *other* marine bacterial communities, with implications for public health (Austin, 1988). Ecological effects, as I argued above, are often subtle and indirect, as this example illustrates. The assumption that the minimal ecological research prior to the Gillespie Inquiry had revealed all risks was therefore unwarranted. The MAF (and therefore prevailing provincial government) attitude, that there was likely to be no risk because the existing evidence had not conclusively proved one, demonstrated a one-sided attitude that is the opposite of the 'honest questioning process' advocated for the treatment of risk in Chapter One.

[27] This conclusion brings out the points made earlier about the impossibility of comprehensively rational, or 'omniscient', decision-making in complex situations: not only is it impossible to predict precisely all the effects of a given decision or action, but it is extremely difficult to envisage "... all of the alternatives that are open to choice" (Simon, 1979, p.500). We seldom know all of the present conditions - such as the existence of uncertified diseases, which must escape any 'comprehensive' sampling procedure.

[28] In the1987 government import policy, it was stipulated that "as of April 1, 1987, egg imports will be limited to 300,000 eggs/year/licence..." and that "after March

31, 1989, no further shipments of Atlantic salmon will be permitted" (DFO, 1987, p.17). The commercial benefits of domesticated Atlantic salmon imports were impliedly recognized: "Consideration for import will be given particularly to stocks that are demonstrably adapted to commercial aquaculture pen rearing...", and an exception to the 1989 deadline was included "... for limited numbers of eggs... under strict supervision of government fisheries agencies" (pp.17-18). Do the 300,000 officially imported in 1990 constitute "limited numbers"?

[29] "When the correctness of a decision can be established unambiguously, the manner [in] which it is reached is largely immaterial; only results count. But when factual and value premises are uncertain and controversial, when objective criteria of success or failure are lacking, the formal characteristics of the decision process - its procedure - become significant" (Majone & Quade, 1977).

[30] Hayek observes of rationalist neoclassical economics that "... there is something fundamentally wrong with an approach which habitually disregards an essential part of the phenomena with which we have to deal: the unavoidable imperfection of man's knowledge and the consequent need for a process by which knowledge is constantly communicated and acquired. Any approach, such as that of much of mathematical economics with its simultaneous equations, which in effect starts from the assumption that people's *knowledge* corresponds with the objective *facts* of the situation, systematically leaves out what is our main task to explain" (Nishiyama & Leube, 1984, p.223).

## CONCLUSION

This thesis has been concerned with how governments should act under uncertainty with the question of what is appropriate, or rational, government behaviour in these circumstances. Behaviour is 'rational', according to the definition employed in the thesis, if it "... is appropriate to the achievement of given goals, within the limits imposed by given conditions and constraints" (Simon, 1964, p.573). In policy towards B.C. salmon farming development, government *goals* - corresponding to government's responsibility for social welfare - have been assumed to include both economic development *and* ecological protection. The tight limits on government resources in the early and mid-1980's, when B.C. salmon farming development began in earnest, have been recognized as particularly strong *constraints* . The problem posed, then, involved the question of how the variety of presumed government goals could best have been met within these constraints.

The establishment, on a significant scale, of salmon farming in B.C. meant introduction of an industry with high growth potential - one new to the province, relatively young elsewhere in the world, and serving a little-developed market - to a little-known coastal environment. Development would thus take place in uncertain and dynamic technological, economic and environmental circumstances. Comprehensive industry planning was unsuitable for rational development, for both ideological and practical reasons: in practical economic terms, for instance - given the ignorance of present conditions and the inevitability that they would change substantially over time - such planning would involve a vast and expensive information-gathering exercise, and the information gathered might quickly become obsolete in the dynamic circumstances. Reliance was therefore placed on the

adaptive market mechanism - assumed to be much more cost-effective and effective at meeting society's economic goals than central planning - to redress the uncertainties over time, and to produce a rational allocation of resources, one in which the industry would be fitted to the requirements of the economic (and social) system.

One manifestation of a policy which relies heavily on the free market for rational resource allocation is minimal government. But even the most dogmatic free market apologists recognize that where the market cannot be made to prevail over resources, as in the case of non-exclusive public goods, there is a residuary role for government in their provision (eg. Hayek, 1960, p.375). Such 'goods' include ecological values, and it falls to government to regulate activities that detract from those values. To do so, though, government must know of the relevant ecological damage. And in circumstances such as those of salmon farming development - the use of new technologies in little-known and complex environmental conditions - ecological effects cannot be assumed to be already known. Since 'the market' does not provide ecological information - which is not (necessarily) reflected in producers' profits and consumers' choices - it falls to government, again, to discover it.

I proposed a rudimentary prescriptive model for this governmental task, based largely on formulations for adaptive environmental assessment and management. In any economic (technological) development in the natural environment, some general kinds of ecological effect can always be anticipated, even if few impacts can be precisely predicted. These anticipations, or imprecise predictions, can then serve as the basis for search for more precise ecological information. This 'search' should be a continuing process, to respond to changes over time and in recognition of the fact that *complete* prediction (prediction of all

specific impacts) is never possible (cf. Holling, 1978, p.3). And though risk-taking is inevitable in any development, it should be *selective*, or based on the best information available in the circumstances, partly to try to avoid irreversible impacts (ibid., p.5). Finally, there should be response to the better information acquired, such as action to prevent future mistakes of the kind which may, ironically, have provided the information in the past.

Next, an attempt was made to 'marry' this adaptive, or procedural, model, with Herbert Simon's formulation of "procedural rationality". This extension of the normative model permitted reintroduction of the cost constraint, as well as increasing the emphasis on the 'reasonableness' of decision-making. As noted above, 'rationality' refers to behaviour that is appropriate to the achievement of given goals within given constraints. But procedural rationality goes beyond that and "... describes an intelligent system's ability to discover appropriate adaptive behavior" (Bartlett, 1986, p.224). "Behavior is procedurally rational when it is the outcome of appropriate deliberation" (Simon, 1976, p.131). Under complex, uncertain conditions, 'appropriate deliberation' includes learning (reducing uncertainty over time), and 'envisioning' different types of relevant information [1]. In these circumstances, in other words, a process cannot be procedurally rational if it neglects information relevant to given goals or fails to reduce uncertainty about how best to achieve them in the future. It is not, therefore, procedurally rational - nor, of course, reasonable - to be biased against any class of relevant information, or to deny uncertainty and the consequent need to learn. The main criteria chosen for a rational government policy were thus: lack of bias against ecological information, and lack of denial of ecological risks, requirements which, because they are minimal, do not violate the expenditure constraint

[2]. For instance, *extensive* search for ecological information was not required, only that any government funding of salmon farming research that *did* take place, *did* not substantially neglect the acquisition of ecological information.

At the beginning of this thesis (p.2) I drew attention to the apparently insoluble puzzle of how government, with very limited resources, could possibly address (subsequently revealed) ecological problems that were unknown to it at the time, without extensive, and prohibitively expensive, 'groping' search for such problems [3]. I also suggested that the 'solution' to this conundrum was the effective 'management' of information over time. Government should learn how to deal with possible ecological problems by responsible trial-and-error and 'successive approximation' towards information precise enough to base action upon. The procedure envisaged is a 'rationally adaptive' one, incorporating the use of imperfect foresight to direct selective search and to prevent unnecessary risk-taking in the trial-and-error search process, timely response to subsequently (adequately) resolved uncertainties, and the balancing of future benefits from information so derived with the direct costs of acquiring it. This procedure requires adequate judgment, or 'reasonableness', for anticipating likely general types of ecological effect, for making the selections to guide search and avoid risks, deciding whether information is accurate enough to prompt action, and balancing present information costs and future benefits. In fact, though, the criteria actually chosen - lack of bias and denial - merely establish the outer parameters (or minimum requirements) for 'reasonableness' within which such judgment should operate, without specifying the precise desiderata for action (which must be left to the discernment of informed participants in the process). (cf. Holling, 1978, p.38 [4].)

In complex, uncertain conditions, where the 'alternatives for choice' (sources of

relevant information) and their consequences (precisely predictable effects) are far from being comprehensively known, reasonable human judgment indeed appears to be quite well-suited to the task of envisioning and learning the missing information, perhaps because of the human ability to imagine and to respond flexibly to novelty. As Simon suggests, "reasonable men' reach 'reasonable' conclusions in circumstances where they have no prospect of applying classical models of substantive rationality [ie. in (the common) circumstances where all alternatives for choice and their consequences are not known]. We know only imperfectly how they do it" (1978b, p.14). Despite the indefinability of the precise learning process, though, and the fact that institutions may not be as flexible in responding to change as individuals, we can prescribe the same minimal requirements of reasonableness (which are in fact little more than approximate principles of common sense) for governments. In other words, governments should not be unreasonably biased against information relevant to social welfare. And, in fact, it may be that the adoption by government of integrated cognitive models can actually hamper the reasonableness, or procedural rationality, of the learning process necessary for achieving this composite social goal.

I have tried to demonstrate the influence of two such (approximately defined) models, or systems of ideas, on ecologically-relevant salmon farming policy. There is no doubt that ideas *can* have an influence on substantive policy - (academic) economic ideas in particular (cf. Rhoads, 1985, p.7) [5]. And it is the 'basic' ideas that influence policy most in real life (ibid., p.3) [6]. The fundamental, 'core' ideas of the neoconservative market model (as delineated by Hayek) are, to put it bluntly, that the adaptive market is good, and rationalist planning is bad. Overwhelming emphasis is thus placed on the 'free' market, which

supposedly maximizes economic growth through competitive selection by the economic system of the 'fittest' firms, those producing the most desired goods and with the highest productivities. Risk-taking (under uncertainty) is fundamental to this process. The market 'learning' mechanism, though, is limited to certain types of information: there is little in individual economic plans to address certain technical issues or, obviously, predominantly collective values such as ecological ones. Academic neoconservative economists may hint, in passing, at non-market social methods of acquiring and responding to this information, but it is peripheral rather than integral to their main system of ideas; so it is not surprising that laymen adhering to the pro-market, anti-planning spirit of that system should ignore the peripheral details. Thus in salmon farming development, the apparently dogmatic rejection of government planning research seems to have influenced the failure of government to gather technical biophysical information on siting that 'the market' (planning by individual firms) was unlikely to provide; and a similar rejection of planning restrictions apparently influenced the failure of government to utilize available information about siting risks and thus to restrict siting in doubtful areas. Both types of information, as revealed after the Gillespie Inquiry, were available at little or no cost, and their use could have prevented ecological siting problems. Also, the apparently dogmatic rejection of government regulation probably influenced the failure of government to attempt to control production practices with known ecological risks. These failures effectively represent bias against ecologically-relevant information and/or denial of ecological risks. There is no escaping the fact that collective ecological values are not goals relevant to the market, which therefore does not search for ecological information and adjust actions to serve ecological goals: a policy based entirely on the free market will make no provision for

them.

Protection of ecological values when ecological effects are uncertain requires, as I said above, that government undertake the necessary search. But if uncertainty is not admitted, ecological risks can be ignored, obviating the need for search and appropriate caution. And it seems that 'basic' ideas from neoclassical economics can be utilized to legitimize this position. Largely for reasons of analytical convenience, neoclassical economics propounds a deterministic notion of rationality. The economic decision-maker is assumed to act not merely rationally, but with *perfect* rationality, thereby maximizing his goals. This assumption, among other such simplifications, permits neoclassical economics to make powerful deductive predictions using elaborate models. Unfortunately, though, the degree of abstraction involved in the underlying assumptions can sometimes be forgotten in making the predictions and prescriptions derived on their basis. Thus pure theorists like Friedman argue that information adequate for maximization, however it is actually acquired, is often possessed by real-world firms. On this evidence, I have argued that neoclassical economics uses a 'sleight of epistemological hand' to infer that 'perfect rationality' - the ability to envisage all alternatives relevant to choice and predict their consequences - is often a reasonable approximation of reality: the basic theory does not carefully distinguish situations which are in fact characterized by a high degree of uncertainty. It is not surprising, then, that policy formulators with only a loose academic understanding utilize the neoclassical rational model - which can only provide accurate predictions and prescriptions under relatively certain conditions - in inappropriate, uncertain situations. Thus in salmon farming policy, the implicit assumption of certainty in government efficiency calculations, in the 'self-policing' argument and the (possible) externality

rationalization, was apparently used to legitimize the early omission by government of ecological search (and of the regulation that depended on it), though this neglect was probably the *result* of other considerations, whether pragmatic or ideological.

### <u>Notes</u>

[1] In highly complex situations such as those relevant to government policy-making, these aspects of rationality are particularly important. As Simon puts it,

[a] general proposition that might be asserted about organizations [such as governments] is that the number of considerations that are potentially relevant to the effectiveness of an organization design is so large that only a few of the more salient of these lie within the circle of awareness at any given time, that the membership of this subset changes continually as new situations (produced by external or internal events) arise, and that "learning" in the form of reaction to perceived consequences is the dominant way in which rationality exhibits itself (1978, p.8).

[2] Simon notes the policy importance both of the often-neglected information about 'side-effects' of major actions (effects which are often ecological ones), and of the constraints on government (the limits on government 'attention'):

The management of [government] attention and the tracing of indirect consequences of action are two of the basic issues of procedural rationality that confront a modern society.... a government, like a human being, is a serial processing system, capable of attending to only one thing at a time. When important new policies must be formulated, public and official attention must be focused on one or a few matters.... When problems become interrelated, as energy and pollution problems have become, there is the constant danger that attention directed to a single facet of the web will spawn solutions that disregard vital consequences for the other facets.... [we must consider] what procedural means are available to order issues on the public agenda in a rational way, and to insure attention to the indirect consequences of actions taken to reach specific goals or solve specific problems (1978, p.13).

[3] The following is a typical exchange from the salmon farming debate which exemplifies the confusing 'circularity' of this problem:

[MAF representative, in response to public claims, based on privately-derived information, that farmed salmon are marketed with chemical residues in their flesh:] ... right now there's no evidence that there are fish going to market with antibiotic residue on it.

[Environmentalist:] That's because nobody's checked it. It's okay to say there's no evidence, but you have to be clear about what the facts are. Nobody's checked it; of course there's no evidence.

[MAF representative:] If you start slinging checking and inspection - .... you know, we're banging this thing back and forth here and not - not moving forward. I understand a lot of people in the audience are aware of some of these issues, so the same allegation can be made if you... look at other fish. Let's leave it at that (NWPS, 1989, p.42).

[4] In similar vein, Holling notes of the more technical prescriptions from AEAM that they are "... not intended to provide a 'cookbook'; such a prescriptive device is the antithesis

of the proposed adaptive management process. Rather, we hope [they will provide] readers with enough of a sense of the order of events that they can begin such an adaptive process on their own. Each situation will be different, however, and the steps described here should be molded to meet specific requirements in each case" (Holling, 1978, p.38).

[5] Thus, Rhoads writes of his book "The Economist's View of the World":

As a political scientist, I would have no reason to write this book if I did not believe that *ideas* about good policy influence political outcomes. I recognize that factors such as electoral strategy, public moods, and interest group pressures also influence public policy, and I know that it can be extremely difficult to weigh the relative importance of all such factors. But if ideas matter at all, and in recent years a number of good political scientists have stressed their political importance, then an examination of economists' views seems especially important. Many economists' ideas that have recently become government policy... appeared years ago in economic books and journals (1985, p.7; italics added).

[6] Thus economists "... readily acknowledge that what they add to the policy process is primarily 'a basic orientation and general framework' or 'the simplest, most elementary concepts of economic theory'" (Rhoads, 1985, p.3).

#### REFERENCES

Alchian, A. (1950). Uncertainty, evolution, and economic theory. *Journal of Political Economy*, 58 (June), 211-21.

Allport, G.W. (1937). Personality: A psychological interpretation . New York: Henry Holt.

- Amacher, R.C. (1984). Economics and public policy. In G.J. McCall & G.H. Weber (eds.), Social science and public policy: The roles of academic disciplines in policy analysis. Port Washington, N.Y.: Associated Faculty Press.
- Austin, B. (1988). Chemotherapy of bacterial diseases of salmonids. In *Congress* proceedings, Aquaculture International Congress & Exposition (6-9 Sept. 1988). Vancouver: Aquaculture International Congress.
- Barry, N. (1984). Ideas versus interests: The classical liberal dilemma. In Hayek's 'Serfdom' revisited (pp.43-64). London: Institute of Economic Affairs.
- Bartlett, R.V. (1986). Ecological rationality: Reason and environmental policy. *Environmental Ethics*, 8 (Fall), 221-39.
- Bauman, G. (1986). *Efficiency and social planning: A means-end confusion* (Working Papers on Social Welfare in Canada: Publication Series). Toronto: University of Toronto, Faculty of Social Work.
- Begon, M., Harper, J.L., & Townsend, C.R. (1986). *Ecology: Individuals, populations, and communities*. Sunderland, Mass.: Sinauer Associates.
- Bourne, N. & Brett, J.R. (1983). Aquaculture in British Columbia. In G.I. Pritchard (ed.), *Proceedings of the National Aquaculture Conference: Strategies for aquaculture development in Canada*. Ottawa: Department of Fisheries and Oceans.
- Brander, J.A. (1988). Government policy toward business. Toronto: Butterworths.
- Brooks, S. (1989). *Public policy in Canada: An introduction*. Toronto: McClelland & Stewart.
- Coopers & Lybrand (1990). The British Columbia salmon aquaculture industry: Financial structure, status and issues (Report prepared for British Columbia Ministry of Agriculture and Fisheries by The Coopers & Lybrand Consulting Group, July 1990). Victoria: Ministry of Agriculture and Fisheries.
- Culhane, P.J., Friesema, H.P., & Beecher, J.A. (1987). Forecasts and environmental decisionmaking: The content and predictive accuracy of environmental impact statements. Boulder, Colo.: Westview Press.

- Daly, H.E. & Cobb, J.B. (1989). For the common good: Redirecting the economy toward community, the environment, and a sustainable future. Boston: Beacon Press.
- DFO (1987). Department of Fisheries and Oceans guidelines for development and operation of finfish aquaculture operations. Draft 87-2, Department of Fisheries and Oceans Pacific Region.
- Dorcey, A.H.J. (1979). Oysters, clams, marine plants: The development of small and beautiful industries. In A.H.J. Dorcey (ed.), *Coastal resources in the future of B.C.* (pp.47-75). Vancouver: Westwater Research Centre, University of British Columbia.
- Dorcey, A.H.J. (1983). Coastal management as a bargaining process. *Coastal Zone Management Journal*, 11 (1-2), 13-40.
- Eckert, R.D. & Leftwich, R.H. (1988). *The price system and resource allocation* (Tenth edition). Chicago: The Dryden Press.
- Egidius, E., Hansen, L.P., Jonsson, B. & Naevdal, G. (1988). *Mutual impact of wild and cultured Atlantic salmon in Norway* (Mini-Symposium on "Case Histories of Effects of Introductions and Transfers on Marine Ecosystems"). Copenhagen: International Council for the Exploration of the Sea.
- Ehrenfeld, D. (1981). The arrogance of humanism. Oxford: Oxford University Press.
- Fox, K.A. & Miles, D.G. (eds.) (1987). Systems economics: Concepts, models, and multidisciplinary perspectives. Ames: Iowa State University Press.
- Fralick, J.E. (1988). British Columbia aquaculture industry development strategy. Victoria: Ministry of Agriculture and Fisheries, Aquaculture and Commercial Fisheries Branch.
- Gillespie, D. (1986). An inquiry into finfish aquaculture in British Columbia (Report and Recommendations). Victoria: Ministry of Forests and Lands.
- Gillespie I (1986). An inquiry into finfish aquaculture in British Columbia (Public Record: Appendix I, Public Meeting Proceedings). Victoria: Ministry of Forests and Lands.
- Gillespie III (1986). An inquiry into finfish aquaculture in British Columbia (Public Record: Appendix III, Government Agency Submissions). Victoria: Ministry of Forests and Lands.
- Gissurarson, H.H. (1984). The only truly progressive policy. In *Hayek's 'Serfdom' revisited* (pp.1-23). London: Institute of Economic Affairs.

Gray, J. (1984). 'The road to serfdom': Forty years on. In Hayek's 'Serfdom' revisited

(pp.25-42). London: Institute of Economic Affairs.

- Hahn, F. & Hollis, M. (1979). *Philosophy and economic theory* (Oxford readings in philosophy). Oxford: Oxford University Press.
- Hall, L.W. & Pinkney, A.E. (1985). Acute and sublethal effects of organotin compounds on aquatic biota: An interpretive literature evaluation. *Crit. Rev. Toxicol.*, 14, 159-209.
- Hartley, K. & Tisdell, C. (1981). *Micro-economic policy*. Chichester, U.K.: John Wiley & Sons.
- Hayek, F.A. (1960). The constitution of liberty. London: Routledge & Kegan Paul.
- Holling, C.S. (ed.). (1978). Adaptive environmental assessment and management (Wiley IIASA, International Series on Applied Systems Analysis, 3). Chichester, U.K.: John Wiley & Sons.
- IFM (1989). Cleaner fish. *Fish* (The Magazine of the British Institute of Fisheries Management), 16 (Winter), 12.
- ITFA (1984). Aquaculture: A development plan for Canada (Final report of the Industry Task Force on Aquaculture sponsored by the Science Council of Canada, August 1984). Ottawa: Science Council of Canada.
- Kesselman, J.R. (1986). Should British Columbia pursue mini-efficiency or social efficiency? In R.C. Allen & G. Rosenbluth (eds.), *Restraining the economy: Social Credit economic policies for British Columbia in the 1980's* (pp.79-97). B.C. Economic Policy Institute. Vancouver: New Star Books.
- Kraus, E. (1974). The unpredictable environment. New Scientist, 63, 649-52.
- Kuttner, R. (1985). The poverty of economics. The Atlantic Monthly, 255 (2), 74-84.
- Lawlor, M.S. (1987). Is the economy a closed system? General equilibrium and general systems theory. In K.A. Fox & D.G. Miles (eds.), *Systems economics: Concepts, models, and multidisciplinary perspectives*. Ames: Iowa State University Press.
- Lindblom, C.E. & Cohen, D.K. (1979). Usable knowledge: Social science and social problem solving. New Haven: Yale University Press.
- Lindgren, B. (1988). Protection zones for salmons a concept for the preservation of genetic diversity of wild salmons and reduction of the spreading of diseases between domestic and wild salmons. Oslo: Norway Ministry of the Environment.
- Macdonald, D.S. (1985). Report of the Royal Commission on the economic union and development prospects for Canada (Volumes I-II & Highlights). Ottawa: Minister of

Supply and Services.

- MAF 24 (1988). B.C. initiatives to assess and manage the environmental effects of marine fish farming, 1987 and 1988 (Aquaculture Information Bulletin No. 24). Victoria: Ministry of Agriculture and Fisheries, and Ministry of Environment.
- MAF 25 (1988). *Measures to ensure safe fish farming in British Columbia* (Aquaculture Information Bulletin No. 25). Victoria: Ministry of Agriculture and Fisheries.
- MAF (1989). Aquaculture licensing and regulations a summary. Victoria: Ministry of Agriculture and Fisheries.
- MAF (1990). Aquaculture in British Columbia: Preparing for the 1990's . Victoria: Ministry of Agriculture and Fisheries
- MAF 25-1 (1990). Measures to ensure safe fish farming in British Columbia (Bulletin No. 25-1). Victoria: Ministry of Agriculture and Fisheries, Aquaculture and Commercial Fisheries Branch.
- MAF 29 (1990). *Nuvan, sea lice, and salmon farming* (Bulletin No. 29). Victoria: Ministry of Agriculture and Fisheries, Aquaculture and Commercial Fisheries Branch.
- MAF 31 (1990). *B.C. initiatives to assess and manage aquaculture-environment interactions* (Bulletin No. 31). Victoria: Ministry of Agriculture and Fisheries, Aquaculture and Commercial Fisheries Branch.
- Maitland, P.S. (1989). The genetic impact of farmed Atlantic salmon on wild populations. Edinburgh: Nature Conservancy Council.
- Majone, G. & Quade, E.S. (1977). Making policy analysis safe. (Unpublished mimeo; quoted in Lindblom & Cohen, 1979, p.66).
- McCall, G.J. & Weber, G.H. (eds.). (1984). Social science and public policy: The roles of academic disciplines in policy analysis. Port Washington, N.Y.: Associated Faculty Press.
- McPhee, M.W. (1982). Implementing management policies and strategies. In Strategies for developing B.C. mariculture: oysters and salmon (Workshop with B.C. Ministry of Environment, 3 Nov. 1982). Draft, Westwater Research Centre, University of British Columbia.
- ME (1980). Commercial fisheries and mariculture: A policy for the 1980's. Victoria: British Columbia Ministry of Environment.
- ME (1990). *Environmental management of marine fish farms*. Draft guidelines, Feb. 1990, B.C. Ministry of Environment, Victoria.

- Meggs, G. (1988). Journey to the future: The report of the Suzuki Foundation fact-finding tour on fish farming in Norway, April 1988 [Supplement]. *The Fisherman*, May 25 1988.
- MEP (1988?). Federal and provincial regulations regarding the movement of fish (Aquaculture Information Bulletin No. 8). Victoria: Ministry of Environment and Parks.
- MF (1983). Budget 1983. British Columbia Ministry of Finance. Victoria: Queen's Printer.
- MF (1984). Budget 1984. British Columbia Ministry of Finance. Victoria: Queen's Printer.
- MF (1985). Budget 1985. British Columbia Ministry of Finance. Victoria: Queen's Printer.
- MOU (1988). Canada/British Columbia Memorandum of Understanding on aquaculture development (6 Sept. 1988). Canada Minister of Fisheries and Oceans, and B.C. Minister of Agriculture and Fisheries.

Mumford, L. (1956). Prospect. In W.L. Thomas (ed.), *Man's role in changing the face of the earth* (pp.1141-52). Chicago: University of Chicago Press.

- NASCO (1987). Bilateral scientific working group on salmonid introductions and transfers (Report of Activities; Annex 13 to the Report of the Fourth Annual Meeting, North American Commission, NAC (87) 20). Edinburgh: North Atlantic Salmon Conservation Organization.
- NASCO (1988). *Potential impacts of salmon farming on wild stocks* (Council Paper CNL(88)21). Edinburgh: North Atlantic Salmon Conservation Organization.
- Nishiyama, C. & Leube, K.R. (1984). *The essence of Hayek*. Stanford: Hoover Institution Press.
- NWPS (1989). Fish farming in B.C. a forum (12 Sept. 1989). Transcript of presentation, Northwest Wildlife Preservation Society, Vancouver, B.C.
- Owen, S. (1988). Aquaculture and the administration of coastal resources in British Columbia (B.C. Ombudsman Public Report No. 15). Victoria: B.C. Ombudsman.
- Pearse, P.H. (1980). Property rights and the regulation of common fisheries. *Journal of Business Administration*, 11 (1&2), 185-209.
- Pearse, P.H. (1982). *Turning the tide: A new policy for Canada's Pacific fisheries* (Commission on Pacific Fisheries Policy, Final Report). Ottawa: Minister of Supply and Services Canada.

- Reddick, D.G. (1988). *The pricing of aquatic lands for aquaculture in B.C.* Unpublished master's thesis, Simon Fraser University, Vancouver, B.C.
- Rhoads, S.E. (1985). *The economist's view of the world*. Cambridge: Cambridge University Press.
- Ricker, K.E. (1989). *Biophysical suitability of the Sunshine Coast and Johnstone Strait/ Desolation Sound areas for salmonid farming in net cages*. Victoria: Ministry of Agriculture and Fisheries, Aquaculture and Commercial Fisheries Branch.
- SAIC (1986). Recommended interim guidelines for the management of salmon net-pen culture in Puget Sound (Science Applications International Corporation, Dec. 1986). Olympia, WA: Washington Department of Ecology.
- Sattaur, O. (1989). The threat of the well-bred salmon. *New Scientist* (29 April 1989), 54-58.
- SCC (1985). Aquaculture: An opportunity for Canadians (Statement by the Science Council of Canada on the role of aquaculture in Canadian fisheries, March 1985). Ottawa: Minister of Supply and Services.
- SCFO (1988). Aquaculture in Canada (Report of the Standing Committee on Fisheries and Oceans). House of Commons, Issue No. 40, Second Session of the Thirty-third Parliament, 1986-87-88.
- Shah, A.B. (1964). Scientific method . Bombay: Allied Publishers Private.
- Simon, H.A. (1947). Administrative behavior . New York: Macmillan.
- Simon, H.A. (1957). *Models of man*. New York: John Wiley & Sons.
- Simon, H.A. (1964). Rationality. In J. Gould & W.L. Kolb (eds.), A dictionary of the social sciences (pp.573-74). New York: Free Press of Glencoe.
- Simon, H.A. (1976). From substantive to procedural rationality. In S.J. Latsis (ed.), *Method and appraisal in economics* (pp.129-48). Cambridge: Cambridge University Press.
- Simon, H.A. (1978a). On how to decide what to do. *The Bell Journal of Economics*, 9 (2), 494-507.
- Simon, H.A. (1978b). Rationality as process and as product of thought (Richard T. Ely Lecture). American Economic Review, 68 (2), 1-16.
- Simon, H.A. (1979). Rational decision making in business organizations. *American Economic Review*, 69 (4), 493-512.

- Solo, R.A. (1975). The economist and the economic roles of the political authority in advanced industrial societies. In L.N. Lindberg, R. Alford, C. Crouch and C. Offe (eds.), *Stress and contradiction in modern capitalism: Public policy and the theory of the state.* Lexington: D.C. Heath & Co.
  - TFPR (1985). Regulation of the fisheries: Terminal case of schizophrenia. In *Regulatory programs: A study team report to the Task Force on Program Review* (pp.269-83). Ottawa: Minister of Supply and Services.
  - Valiela, D. (1982). Identifying priority mariculture areas for oysters and salmon. In Strategies for developing B.C. mariculture: oysters and salmon (Workshop with B.C. Ministry of Environment, 3 Nov. 1982). Draft, Westwater Research Centre, University of British Columbia.

## Newspaper articles

The Fisherman, 16/8/85. Fish farms: a bad idea getting worse. Alaskan government puts
brakes on farms.
The Fisherman, 18/11/85. DFO gives the green light to more foreign egg imports.
The Fisherman, 12/12/'85. Salmon farm moratorium wins B.C. Fed support.
The Fisherman, 18/4/'86a. Danger at the farm.
The Fisherman, 18/4/'86b. Geoff Meggs. Fish farm fiasco.
The Fisherman, 21/5/'86. Disease risk prompts plan to ban salmon egg imports.
The Fisherman, 23/6/'86a. Davin Karjala. Aquaculture: The boom out of control.
The Fisherman, 23/6/'86b. Diane Evans. Protest against aquaculture forces Victoria
policy review. p.7.
The Fisherman, 18/7/'86. DFO aquaculture subsidy hits \$3 million in '85.
The Fisherman, 19/9/'86. Norway moves on wild stock as B.C. farm leases explode.
The Fisherman, 11/'86. Toxic chemical detected in farm salmon.
The Fisherman, 12/12/'86. Geoff Meggs. Gillespie lifts farm freeze but major problems
unsolved.
The Fisherman, 25/3/87. TBT banned for fish farms after B.C. supply seized.
The Fisherman, 22/5/'87. Studies find TBT in B.C. farmed fish.
The Fisherman, 17/7/'87. Alaska imposes firm fish farm moratorium.
The Fisherman, 17/2/'89. Governments, farm industry undertake first checks on quality,
antibiotic use.
The Fisherman, 21/4/'89. Memo slams fish farm operations.
Globe & Mail, 2/1/90. Leonard Silk. Cocky economists urged to depend less on theories.
New York Times, 7/3/'89. Timothy Egan. Fish and eggs destroyed in West after disease
strikes hatcheries B8
Vancouver Sun 10/12/88 Bruce Constantineau Ombudsman recommends new set of fish
farm rules - R9

APPENDICES

I. 1986 (pre-Gillespie Inquiry) B.C. salmon farm licensing structure

(Courtesy B.C. Ministry of Agriculture and Fisheries)

# MOINT AND LICENCE STRUCTURE FOR MARINE FINFISH CULTURE



<sup>3)</sup> Marine Fish Farm Production Plan was previously called Salmon Farm Management Plan.

II. 1989 (post-Gillespie Inquiry) B.C. salmon farm licensing structure (Courtesy B.C. Ministry of Agriculture and Fisheries)

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PERMITIS AND LICENCE STRUCTURE FOR AQUACILITURE



III. Possible effects of salmon farming on the marine environment ('worst case' scenario of

poor siting and farm operation)

(Courtesy Ministry of Environment)



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