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The State-Spaced Integrated assessment model for Newfoundland's 'northern cod' as a stock assessment that fails to distinguish between normative and natural laws

Christopher J. Corkett

Biology Department, Dalhousie University, Halifax, Nova Scotia, B3H 4J, retired

Current address: 85 Prestwick Close, Apt 117, Halifax, Nova Scotia, B3S 1P5

E-mail address: chris.corkett@dal.ca

Science is not magic. While a fairy godmother can use a magic wand to turn pumpkins into golden carriages, Dr Noel Cadigan cannot use advanced statistics to turn scientific and fisheries data into advice

Abstract: Stock assessment models for Atlantic Canada's groundfish fisheries such as Noel Cadigan's recent State-Spaced Integrated assessment model for Newfoundland's 'northern cod' involve single premised inductive arguments that do not distinguish between *normative* and *natural* laws. By contrast, management of Canada's inshore Maritime lobster fishery has involved a dual premised deductive argument in the form of a critical dualism in which *normative* regulations are developed by trial and error, guided by negative feedback from the *natural* universal law of sustainability. It is my thesis that if Atlantic Canada's groundfish fisheries are to avoid further collapse they will, like the inshore lobster fishery, have to be managed by a critical dualism in which decisions are taken (not made). In this dual premised deductive argument catch limits (quotas) representing *normative* laws, would be developed by trial-and-error involving the method of 'selection by error elimination' guided by universal *natural* laws such as the universal law of sustainability, theories that explain what cannot be achieved by the whole groundfish fishery and what should not therefore be attempted by the fishery as a whole.

Keywords: induction; monism; deduction; demarcation; fisheries; norms; sustainability

Introduction

Dr. Noel Cadigan, a quantitative fisheries scientist with the Marine Institute of Newfoundland's Memorial University, has recently been appointed the **First Choice International Research Chair in Stock Assessment and Sustainable Harvest advice for Northwest Atlantic Fisheries**. On the face of it this is a good news story. However Noel Cadigan's new State-Spaced Integrated assessment model for Newfoundland's stock of 'northern cod' (Cadigan, 2016) does nothing to correct a fundamental problem underlying the traditional method of a fisheries science or fish stock assessment. That is: the fishery scientist or fish stock assessor has never understood that a fundamental distinction has to be made between (a) a natural universal law associated with 'science' and (b) a legal or normative law associated with 'policy.' Noel Cadigan's State-Space Integrated assessment model for example, treats a 'quota' as a scientifically achievable prediction, whereas for an output managed fishery[1] such as the Atlantic groundfish fishery, a quota or catch limit is a normative law involving man-made rules in the same way the inshore Maritime lobster fishery is governed by man-made normative regulations.[2]

Method

Analytic demarcation

The collapse of Atlantic Canada's groundfish fishery in the early 1990s has been described by Tony Charles (1997) as forming 'the most prominent global case study of failure in fishery management' and this working paper forms one more study of this failure. However this paper's methodological approach breaks new ground by treating 'fisheries method' not as a

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1 Output controls are direct limits on the amount of fish coming out of a fishery such as a normative quota or catch limit.

2 Input controls are restrictions put on the intensity of the use of gear to catch fish. In the inshore Maritime lobster fishery these normative controls have included: prohibition against landing egg-bearing females; minimum size limits; licensing of fishermen (limited entry); restriction on the gear used (traps); limitation on the number of traps; division of the coastal area into lobster fishing areas (LFAs); fishing seasons determined by LFA (FRCC, 1995, p. 12).

quantifiable science (as do for example Hilborn and Walters (1992)) but as an analytic demarcation in which (i) a **selective view of fisheries science** is demarcated from (ii) an **instructive view of fisheries science** or as it is usually called **induction** [3] (Corkett, 2017, section 2).

Non-empirical program of research

I have had two research programs in my 50+ year career. The first (1963 to 1992) was an empirical program of research on the biology of the marine copepods that play an important role in the food chain of Gadoid fisheries (Corkett and McLaren, 1978). The second is a non-empirical program of research based on Karl Popper's political philosophy (1993 to present) in which a deductive *critical dualism* is demarcated from a *monism*, an inductive argument that fails to distinguish between normative and natural laws and is characteristic of a 'closed society.'

> I believe that it is necessary for the understanding of Plato's sociology to consider how the distinction between natural and normative laws may have developed…. The starting point can be described as a *naïve monism*. It may be said to be characteristic of the 'closed society.' The last step, which I describe as *critical dualism*… is characteristic of the 'open society.' The fact that there are still many who try to avoid making this step [4] may be taken as an indication that we are still in the midst of the transition from the closed to the open society (Popper, 1966, p. 59, his emphasis).

[3] In the early 1970s I held a National Environment Research Council (NERC) Fellowship at the Marine Biological Association, Plymouth where I produced a paper in the ephemeral discipline of physiological ecology (Corkett, 1972). This work made use of a single premised argument in the form of a 3-parameter equation and the difficulty I experienced in handling this argument led me to take an interest in Karl Popper's non-inductive theory of method with its dual premised critical dualism as an organon of criticism.

[4] Fishery scientists and fish stock assessors are examples of those 'who try to avoid making this step.'

Normative laws vs natural laws

A science that deals with policy such as a fisheries science has to be very careful to distinguish between laws that deal with policies such as legal laws and laws that deal with a science such as natural laws. That is: a competent fisheries science has to distinguish between (a) man-made normative laws and (b) natural universal laws. I can illustrate how this distinction is upheld for a commercial fishery with reference to the successful management of the 145+ year old inshore Maritime lobster fishery.[5]

The management of the Maritime lobster fishery has been carried out by trial-and-error involving the method of 'selection by error elimination' a version of the more general method of 'selection by critical elimination' (see Corkett, 2015, his, Figure 1 for illustration of the method

Table 1 Early normative regulations developed to control effort levels in the inshore Maritime lobster fishery (from FRCC 1995, p. A24).

Dates	Regulations
1871	Protection of egg females and small lobsters (<1½ lbs)
1872 – 1898	Variety of changes in size limits
1910	Abolition of size limits
1919	Licence required
1934 – 1957	Variety of changes in size limits
1966	Trap and licence limitations

[5] While the inshore Maritime lobster fishery has been successfully managed for some 150 years without collapse, the Maine lobster fishery has endured a collapse. 'The 200+ year old lobster fishery in Maine and New England has collapsed. Not as bad as cod, but bad nevertheless. It happened in the teens and twenties of the last century, in Maine landings dropped to 2 to 5 million pounds, today they are close to 130 million pounds' Wilson, J. (2016, personal communication).

of 'selection by critical elimination') [6] in which input regulations are developed to control effort levels in order to maintain a sustainable fishery. The Canadian inshore Maritime lobster fishery is one of Canada's most regulated fisheries. These regulations are man-made rules that have been developed by a trial-and-error management and form examples of normative laws (Table 1). These normative regulations are to be distinguished from a natural universal law that guides the trial and error management of the whole lobster fishery. The universal law of sustainability is an example of such a natural law and it can be given as:

> You cannot maintain a sustainable lobster fishery (goal) if the lobster landings are continuously declining. That is: if the lobster landings are continuously declining enhance the input regulations to better control effort levels.

A universal law makes a negative prediction which explains why the law is able to apply to the whole fishery. That is: the universal law of sustainability explains what cannot be achieved and what should not therefore be attempted by trial-and-error management. Different Lobster Fishing Areas (LFAs) may develop different management traditions and could develop different normative regulations but all these management traditions are guided by the same universal law of sustainability.

An instructive view of fisheries science

All this is very different in the quota management of the Atlantic groundfish fishery such as the fishery for Atlantic cod. The latest stock assessment model for Newfoundland's 'northern cod' has been developed by Dr Noel Cadigan and is based on many different sources of fisheries and scientific data from the northern stock area (Cadigan, 2016). This assessment model will guide the future management of the stock of 'northern cod' by using advanced statistics to turn large amounts of 'northern cod' data into advice for the Minister by, for example, giving the

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[6] The two methods of 'selection by error elimination' and 'selection by critical elimination' have as their own paradigm Darwin's theory of natural selection where natural variants are weeded out, so that only the useful ones survive (Corkett, 2017, section 3.3).

Minister advice on the appropriate size for a harvestable quota or catch limit. However this scientific advice is based on a *positive prediction* of future performance and could never be used to guide a trial-and-error management of the whole Atlantic groundfish fishery like a natural universal law's *negative prediction.*[7] The harvestable quota or catch limit for the assessment model for 'northern cod' is in fact a normative law involving man made rules like the regulations for a lobster fishery (Table 1). That is: under a selective view of fisheries science an output quota for a groundfish fishery has to be developed by trial and error in the same way an input regulation for a lobster fishery is developed by trial and error.

A selective view of fisheries science

Under a selective view of science a fundamental distinction is made between (a) the prediction of an event involving a *natural* law of nature such as the prediction of the return of Haley's comet (Figure 1) involving Newton's theory of gravitation (Table 2A) and (b) the trial-and-error development of *normative* regulations. From the point of view of a fisheries management this distinction is upheld by a dual premised deductive scheme referred to as a critical dualism (Table 2B). In this scheme normative regulations or laws [8] are derived by trial and error guided by the negative predictions of natural universal laws [9] such as the universal law of sustainability. Consider the task of managing a sustainable fishery; the goal of sustainability is a norm that reflects the values of the participants and forms the conclusion in Table 2B. What remains to be found by the fisheries manager are the normative laws that have

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[7] In the philosophy of science this negative prediction is modelled by a universal law such as *all swans are white;* that is: black swans do not exist, i.e. you will not find a black swan. The universal law of sustainability takes the logical form of: *all swans are white* by explaining what cannot be achieved and what should not therefore be attempted.

[8] Normative laws (in contrast to natural laws) take the logical form of a 'there-is' statement such as *at least one white swan exists*, a logically weak 'some-notion' (Corkett. 2017, his note vii) that cannot be falsified (Corkett, 2017, his note ii).

[9] Natural laws (in contrast to normative laws) take the logical form of a universal law such as *all swans are white*, a logically strong 'all-notion' (Corkett, 2017, his note vi) that asserts non-existence (see note 7) and cannot be verified (Corkett, 2017, his note ii).

to be realised by trial-and-error in such a way that the conclusion of the Table is deductively implied by the dual premises of the Table (Corkett, 2017, section 3.1)

Table 2 A, The prediction of an event by Newton's theory of gravitation (from Popper, 1979); **B**, The critical dualism of a **selective view of fisheries science** (from Corkett 2017, his Table 1A; **C**, The inductive monism of an **instructive view of fisheries science** (from Corkett 2017, his Table 1B).

	A	**B**	**C**
	Prediction of event	**Critical dualism**	**Inductive monism**
Universal premise	Newton's theory of gravitation	**Universal Law** of Sustainability	
Singular premise	'initial conditions'	trial-and-error development of **normative laws**	Observations or data
Conclusion	Prediction of a future event such as the return of Halley's comet ‡	Goals and objectives as **norms** (values) chosen by the participants	Scientific prediction of advice as MSYs;† quotas or catch limits₴

‡ See Figure 1

† Under an instructive view of fisheries science goals and objectives do not form norms (values) but are viewed as scientifically achievable predictions. For example the goal of sustainability is predicted as a maximum sustainable yield (MSY) derivable from data; for example an Area 2 stock of Pacific halibut has a MSY of 30 million pounds (Corkett, 2017, his Figure 2(b)).

₴ Under an instructive view of fisheries science normative laws are not man made rules developed by a trial-and-error but are viewed as scientifically achievable predictions. For example Noel Cadigan (2016) views a quota or catch limit as a scientifically achievable prediction derivable from scientific and fisheries data.

Figure 1 The appearance of Halley's comet in 1066 was recorded on the Bayeux Tapestry (from Wikipedia). The successful prediction of successive appearances of this comet form an example of the 'prediction of an event' involving a law of nature such as Newton's theory of gravitation (Table 2A).

Discussion

Negative bold content vs positive prediction

Newton's theory of gravitation (Table 2A) carries bold content (negative information) in the form of refutability (Corkett, 2017, his note viii). The universal law of sustainability (Table 2B) carries bold content in the form of falsifiability. That is: the universal law *all swans are white* excludes the existence of black swans and the 'observation' of a black swan falsifies the universal law (see notes 7 and 9). By contrast a fisheries science that takes an instructive view of science argues inductively (Table 2C) and takes the logical form of a 'there is' statement (see note 8), 'predictions' that cannot be falsified and have more to do with a non-falsifiable mathematics [10] than a falsifiable natural law with bold content. It is the boldness of a natural law (given in Table 2 by the universal premise) that guides the management of a whole fishery by showing what cannot be achieved and should not therefore be attempted by management. For example management of the whole Maritime lobster fishery is guided by a universal natural law with the logical form of: *all swans are white* (black swans do not exist), as:

> You cannot maintain a sustainable lobster fishery (goal) if the lobster landings are continuously declining.

The *negative* bold content of this natural law contrasts with Noel Cadigan's view of a 'quota' as a scientifically achievable prediction, a *positive* prediction that could never guide the trial and error management of a whole fishery by explaining what cannot be achieved.

Conclusion

Management of Atlantic Canada's groundfish fishery involves an inductive argument in the form of a single premised monism (Table 2C) in which fishery scientists such as Dr Cadigan aim to share responsibility for their decisions and advice with the 'facts' as data. In this instructive view of fisheries science decisions are *made* not taken, a philosophical position

[10] See examples of non-falsifiable 'predictions' with no bold content in Corkett, 2017, section 2.1.

referred to as a 'scientific' ethics (Popper, 1966, p. 237, note 18) that is characteristic of a closed society.

It is my thesis that if the groundfish fishery of Atlantic Canada is to avoid further collapse it will need to be managed by the deductive argument of a dual premised critical dualism (Table 2B) in which a trial-and-error management is guided by negative feedback from natural universal laws that explain what cannot be achieved by the whole fishery. In this selective view of fisheries science decisions are *taken* not made. That is: fishery scientists take personal responsibility for their decisions and advice as in an open society.

I may not be a stock assessment expert but as a scientific peer of Dr Noel Cadigan I give notice that I consider myself the 'official critic' of the quantitative method of fish stock assessment in which decisions are *made* not taken. Under Karl Popper's non-inductive theory of method induction does not exist as a valid argument. That is: under a selective view of fisheries science decisions have to be *taken*; only afterwards can they be criticised by a *deductive logic* in which deduction forms the organon of criticism.

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My contribution to this research is dedicated to the memory of Warwick C. Kimmins, a colleague from Chelsea College of Science and Technology, UK.

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