

1 Description of the PoliSEA model following the ODD+D protocol (Müller *et al.* 2013)

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Outline		Guiding questions	
<b>I) Overview</b>	I.i Purpose	I.i.a What is the purpose of the study?	Exploring the role of interest group properties (funding and influence), issue-related conditions (issue salience) and structure of the political system (beliefs of policymakers) in the mechanisms through which interest groups influence policy adaptation and sustainability of the fishery.
		<b>I.ii.b For whom is the model designed?</b>	For scientists: social-ecological system researchers, researchers interested in political behaviour and the role of non-state actors in adaptive governance
	I.ii Entities, state variables, and scales	I.ii.a What kinds of entities are in the model?	<b>political agents:</b> interest groups, interest group coalitions, policymakers <b>an ecological entity:</b> fish population <b>an economic entity:</b> fishery <b>a social entity:</b> public
		I.ii.b By what attributes (i.e. state variables and parameters) are these entities characterized?	<b>interest groups:</b> type, funding, influence, concern threshold, policy preference <b>interest group coalitions:</b> type, funding, influence, policy preference, members <b>policymakers:</b> beliefs, policy preference <b>fish population:</b> carrying capacity, reproduction rate, price of fish <b>fishery:</b> quota, seasonal catch, income <b>public:</b> issue salience
		<b>I.ii.c What are the exogenous factors / drivers of the model?</b>	none (in future we plan to introduce environmental fluctuations/shocks)
		<b>I.ii.d If applicable, how is space included in the model?</b>	not applicable
		I.ii.e What are the temporal and spatial resolutions and extents of the model?	<b>temporal:</b> yearly timesteps, each year represents a fishing season <b>duration:</b> 50 seasons, with a long-term scenario of 100 seasons

	I.iii Process overview and scheduling	I.iii.a What entity does what, and in what order?	Interest groups perceive signals from the fishery, update their concern with the issue, decide whether to lobby in coalitions or alone, look for coalition partners and attempt to ally, form coalitions (new agent). Coalitions and interest groups lobby policymakers. Policymakers update their current policy preferences, vote for increasing or decreasing the quota. Quota is implemented in the fishery, fish population reproduces. Fishery harvests the quota (if there is enough fish left to fill it) and sells it, receiving income. Public responds to the change in fish population if the issue is salient.
<b>II) Design Concepts</b>	<b>II.i Theoretical and Empirical Background</b>	II.i.a Which general concepts, theories or hypotheses are underlying the model's design at the system level or at the level(s) of the submodel(s) (apart from the decision model)? What is the link to complexity and the purpose of the model?	Population dynamics Bioeconomics (logistic growth model) Fishery as a social-ecological system Neopluralist model of politics Advocacy Coalitions Framework
		<b>II.i.b On what assumptions is/are the agents' decision model(s) based?</b>	See Table 1 of the manuscript for a description of key assumptions and references.
		<b>II.i.c Why is a/are certain decision model(s) chosen?</b>	Based on an empirical study of interest group role in 2013 EU Common Fisheries Policy reform <sup>5</sup> and literature on interest group behaviour and influence.
		<b>II.i.d If the model / a submodel (e.g. the decision model) is based on empirical data, where does the data come from?</b>	Research published in Orach <i>et al.</i> <sup>5</sup>
		<b>II.i.e At which level of aggregation were the data available?</b>	-
	<b>II.ii Individual</b>	<b>II.ii.a What are the subjects and objects</b>	<b>Subjects</b> of decision-making are interest groups, interest group coalitions and policymakers.

	<b>Decision Making</b>	<b>of decision-making? On which level of aggregation is decision-making modeled? Are multiple levels of decision making included?</b>	<p><b>Objects</b> are the fishing quota, other interest groups, coalitions and policymakers</p> <p>Decision making is modeled at the level of the individual (policymaker, interest group lobbyist) and a collective entity (interest group coalition). Interest groups contribute to the coalition with funding and influence, however decisions are made by a coalition as an aggregate entity.</p>
		<b>II.ii.b What is the basic rationality behind agents' decision-making in the model? Do agents pursue an explicit objective or have other success criteria?</b>	<p><b>Value rational:</b> interest groups and policymakers pursue policy options that reflect their type or beliefs.</p> <p>Interest groups seek to lobby and change policy in accordance to their policy preferences. Policymakers seek to change policy according to their current preferences through voting.</p>
		<b>II.ii.c How do agents make their decisions?</b>	<p><b>Interest groups:</b> Interest groups always lobby if funding allows them to lobby at least once during the current season. Interest group policy position depends on the type of interest (e.g. industry groups lobby for quota increase, environmental groups lobby for quota reduction). Interest groups check the size of the fish population (environmental) or the seasonal income of the fishery (industry). If the perceived signal is lower than the interest group concern threshold, the group can decide that the issue is in a critical state and thus it is important to mobilize against opposition through forming coalitions with like-minded groups. In case of concern, interest group has a 60% chance to decide to lobby in a coalition. When choosing which group or existing coalition to ally with interest groups have a preference for selecting groups or coalition with highest influence. When attempting alliance, there is also a 60% likelihood that the groups will agree on terms and form a coalition.</p> <p><b>Interest groups and Interest group coalitions:</b> Interest groups that lobby alone (or did not manage to find a coalition partner) look for a potential lobbying target among policymakers. Their choice is dependent on the beliefs of policymaker. The closer the policymaker beliefs are to the moderate or undecided position, the more likely they are to be the target for lobbying. Each lobbying attempt costs a set amount of funds, which interest groups and coalitions deduct from their seasonal funding each time they attempt to influence a policymaker. Lobbyists have to make a new</p>

			<p>decision on whom to lobby after every attempt, until their funding is exhausted.</p> <p><b>Policymakers:</b> Prior to lobbying policymakers determine their current policy position. Policymaker's position is determined solely by their belief: 'pro-industry' policymakers (1-5 on the belief scale) would vote for a quota increase, while 'pro-environmental' agents (6-10 on the belief scale) would vote to decrease the fishing quota. During a lobbying interaction, the policymaker may change their mind and alter their policy position with a probability that is dependent on the lobbyist's influence.</p> <p>After the lobbying stage is over (all interest groups have exhausted their funding for this season), the policymakers decide how to vote for next season's quota. Their vote is determined by their policy position after the lobbying round. Policymakers with a pro-industry position (1-5) vote for quota increase, while policymakers with a pro-environmental position (6-10) vote for decrease.</p>
		<b>II.ii.d Do the agents adapt their behaviour to changing endogenous and exogenous state variables? And if yes, how?</b>	Interest groups adapt their lobbying strategy based on signals perceived from the fishery social-ecological system. Industry groups pay attention to fishery income signals, while environmental groups – to the state of fish population. If the signal falls below the interest group concern threshold, interest group will be more likely to seek alliance rather than lobbying alone.
		<b>II.ii.e Do social norms or cultural values play a role in the decision-making process?</b>	Not explicitly, but believes held by interest groups and policymakers could potentially reflect cultural values or social norms.
		<b>II.ii.f Do spatial aspects play a role in the decision process?</b>	No
		<b>II.ii.g Do temporal aspects play a role in the decision process?</b>	Not directly. Interest groups success or failure to influence policy in the previous season does not impact group funding or influence. However, if interest group failure to influence policy can lead to adverse (for that interest group) impacts on fish population and fishery income via quota. E.g. if industry groups managed to be successful for an extended period of time, the quota and thus catches are increased, so that the fish population declines faster. After fish population declines beyond environmental groups critical threshold, these groups

			will be more likely to organize and lobby in coalitions to change the quota.
		<b>II.ii.h To which extent and how is uncertainty included in the agents' decision rules?</b>	Uncertainty is not explicitly included in agents' decision rules. However, interest group address uncertainty related to behaviour of opposing groups through choosing to lobby undecided policymakers (to counteract potential efforts of opposing groups).
	II.iii Learning	II.iii.a Is individual learning included in the decision process? How do individuals change their decision rules over time as consequence of their experience?	Learning is included indirectly through interest groups perceiving social and ecological signals. Interest group do not learn to choose particular lobbying strategies (e.g. coalition-building), however can change their behaviour in response to signals, worsened or improved by the change in quota.
		<b>II.iii.b Is collective learning implemented in the model?</b>	No
	<b>II.iv Individual Sensing</b>	II.iv.a What <b>endogenous</b> and <b>exogenous</b> state variables are individuals assumed to sense and consider in their decisions? <b>Is the sensing process erroneous?</b>	Interest groups sense signals from the fishery SES. Particularly environmental groups perceive information about the state of the fish stock, while industry groups perceive information about the state of fishery seasonal income. The potential for bias in sensing is included in the model however not used for the purpose of the study.
		II.iv.b What state variables of which other individuals can an individual perceive? <b>Is the sensing process erroneous?</b>	Interest groups can sense type and influence of other groups and coalitions when attempting to join coalitions and beliefs / policy position of policymakers when deciding who to lobby. Policymakers can sense interest group influence and beliefs when lobbied. These sensing processes are not erroneous.
		II.iv.c What is the spatial scale of sensing?	-
		II.iv.d Are the mechanisms by which agents obtain information modeled	Interest groups obtain this information during the respective stages of the policy process (e.g. beliefs of policymakers become known to the interest groups during the lobbying interaction).

		explicitly, or are individuals simply assumed to know these variables?	
		<b>II.iv.e Are costs for cognition and costs for gathering information included in the model?</b>	No
	II.v Individual Prediction	<b>II.v.a Which data do the agents use to predict future conditions?</b>	-
		II.v.b What internal models are agents assumed to use to estimate future conditions or consequences of their decisions?	-
		<b>II.v.c Might agents be erroneous in the prediction process, and how is it implemented?</b>	-
	II.vi Interaction	II.vi.a Are interactions among agents and entities assumed as direct or indirect?	Interest groups interact with other groups directly through coalition-building and indirectly through competition for policymakers during lobbying. Policymakers interact with interest groups directly during interest group lobbying and with other policymakers indirectly through voting.
		<b>II.vi.b On what do the interactions depend?</b>	Interactions between interest groups depend on the decision of interest groups to form coalitions and on the type/influence of potential allies. Interactions between interest groups and policymakers depend on policymaker beliefs.
		II.vi.c If the interactions involve communication, how are such communications represented?	Communication is assumed to occur during the processes of coalition-formation and lobbying. For example, the likelihood of interest group to form a coalition with other interest group is assumed to reflect the potential costs of coalition-building and difficulty in finding a common ground during the negotiation over a common policy position.

		<b>II.vi.d If a coordination network exists, how does it affect the agent behaviour? Is the structure of the network imposed or emergent?</b>	-
	II.vii Collectives	II.vii.a Do the individuals form or belong to aggregations that affect, and are affected by, the individuals? Are these aggregations imposed by the modeller or do they emerge during the simulation?	Interest groups can form interest group coalitions to lobby policymakers. The coalitions are emergent and represent a separate independent agent. Upon joining a coalition, interest groups resources and influence are pooled and transferred to the coalition agent.
		II.vii.b How are collectives represented?	Coalitions are represented as an independent lobbying agent
	<b>II.viii Heterogeneity</b>	<b>II.viii.a Are the agents heterogeneous? If yes, which state variables and/or processes differ between the agents?</b>	Interest groups are heterogeneous in their type, funding and influence. Interest group funding and influence are distributed according to a normal distribution around set mean values. Policymakers are heterogeneous in their beliefs. Their beliefs are distributed according to policymakers according to the scenarios used in the model analysis.
		<b>II.viii.b Are the agents heterogeneous in their decision-making? If yes, which decision models or decision objects differ between the agents?</b>	Interest groups are heterogeneous in their decision-making, based on their type (industry/environment). Industry interest groups perceive and respond to fishery income signals, while environmental groups perceive and respond to fish population signals from the fishery social-ecological system.
	II.ix Stochasticity	II.ix.a What processes (including initialization) are modeled by assuming they are random or partly random?	Interest groups seek coalition partners, form coalitions and lobby in random order. Policymakers vote in random order.
	II.x Observation	II.x.a What data are collected from the	Fish population Seasonal catch

		ABM for testing, understanding, and analyzing it, and how and when are they collected?	Number of interest group coalitions of both types Total influence of coalitions Number of interest groups with funding insufficient for lobbying
		II.x.b What key results, outputs or characteristics of the model are emerging from the individuals? (Emergence)	Fish population & catch (sustainability of the fishery) Interest group coalition dynamics
<b>III) Det ails</b>	<b>II.i Implementat ion Details</b>	<b>III.i.a How has the model been implemented?</b>	NetLogo.
		<b>III.i.b Is the model accessible and if so where?</b>	
	III.ii Initialization	III.ii.a What is the initial state of the model world, i.e. at time t=0 of a simulation run?	Starting fish population = 5000 individuals Carrying capacity = 10000 individuals Reproduction rate = 0.2 Starting quota = 500 individuals Quota change = 50 individuals Fish price = 1SEK  Concern threshold environment = 4000 individuals Concern threshold industry = 480 individuals Mean influence environment = 10 Mean influence industry = 20 Mean funding-environment = 20 Mean funding industry = 40 Lobbying cost = 10 Policymaker belief values = 20-60-20 Likelihood of coalition = 0.6  issue-salience = 1 Dynamic issue salience = true
		III.ii.b Is initialization always the same, or is it allowed to vary among simulations?	Mean influence and funding for environmental and industry interest groups, policymaker values and issue salience were varied among simulations



		III.ii.c Are the initial values chosen arbitrarily or based on data?	The difference between influence and funding of environmental and industry interest groups was chosen to reflect industry group advantage in lobbying observed in empirical research <sup>13</sup> .
	III.iii Input Data	III.iii.a Does the model use input from external sources such as data files or other models to represent processes that change over time?	-
	III.iv Submodels	III.iv.a What, in detail, are the submodels that represent the processes listed in ‘Process overview and scheduling’?	<p>Logistic model of fish population growth:</p> $N_{t+1} = N_t + N_t r \left(1 - \frac{N_t}{K}\right) - H_t$ <p>Here <math>N_t</math> represents the fish stock at time <math>t</math>, <math>r</math> the growth rate, <math>K</math> the carrying capacity, <math>H_t</math> the total harvest at time <math>t</math>, which corresponds to the allowed quota when the fish population is sufficiently large or to the remaining fish stock if not.</p>
		III.iv.b What are the model parameters, their dimensions and reference values?	-
		III.iv.c How were submodels designed or chosen, and how were they parameterized and then tested?	-