

Making rules to live by: Was the proposed regulatory regime for invasive species reasonable? Perceptions of the South African trout industry

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Abstract: Despite considerable economic impact of trout-based aquaculture and recreational fishing, the Department of Environmental Affairs has been focusing almost entirely on ecological criteria in deciding the regulatory regime for trout. We examined whether the proposed regulatory regime for alien and invasive species that was published by the Department of Environmental Affairs in 2014 for public comment was reasonable. The analysis produced factors that might matter in the design of reasonable institutional arrangements that impose a reasonable regulatory burden on economic sectors utilising invasive species. We conducted factor analysis using an online survey that we conducted between May and July 2014. We obtained four clusters of factors: participatory policymaking, people-centeredness, credible scientific evidence for listing species as invasive and contextualisation of international evidence. We then utilised the factors in a logistic regression framework to assess their influence on the probability of perceiving the regulations to be reasonable. The likelihood of a trout sector player perceiving the regulations to be reasonable was 1.2%. We found that a one standard deviation increase in the “credibility of scientific evidence” increased the odds of perceiving the regulations to be reasonable by 1645%. A one standard deviation increase in “participation” increased the odds of perceiving the regulations to be reasonable by 410%. A one standard deviation increase in “people-centeredness” increased the odds of perceiving the regulations to be reasonable by 600%. Lastly, a one standard deviation increase in the variable “contextualising international evidence” increased the odds of perceiving the regulations to be reasonable by 415%. This research demonstrates that properly addressing the socio-economic aspects of new policies in addition to ecological criteria makes it far more likely that stakeholders will regard them as reasonable, even if the new policies impose increased regulatory transaction cost burden on users or reduced access to a resource.

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1. Policy problematiques

Humanity through knowledge has become, as it were, “clueless” of how to solve environmental, political, economic and social problems of global dimensions, which, through knowledge, it first created. The oxymoronic increase in epistemic communities, which implies a significant increase in knowledge, and a sustained increase in institutional sclerosis, suggests a knowledge curse phenomenon. The Club of Rome describes the oxymoron as an “era of scientific and technological advancement [that] has brought us unparalleled knowledge and power, [yet] we are witnessing the sudden emergence of a “world problematique”” (Botkin et al. 2014, 1). Max-Neef (2005, 5) defines problematiques as “problems of global and long term impact” and whose “adverse trends are steadily strengthening” (Botkin et al. 2014, 1).

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In their seminal paper, Rittel and Webber (1973, 155) describe the problematiqués as “wicked problems”, which are non-tameable policy problems simply because there are divergent social theories, belief systems and value systems none of which can individually satisfactorily coordinate resolution processes. Yet, “science has developed to deal with “tame” problems” (Rittel and Webber 1973, 155) or as King (1993, 106) puts it: “the great forte of science” for several centuries has been the resolution of tame problems. The view that divergent theories, belief systems and value systems characterise wicked problems, suggests that knowledge is a critical input into the design of new institutions. The problem is whose, and which, theory/knowledge matter and how are the different natural science and social theories weighed in the course of deciding the process of institutional change.

The Club of Rome states that increases in knowledge mean increases in power. The question is how the power is used to address the problems. Whose knowledge and therefore, whose power matters? As far as problematiqués are concerned “none of them can be adequately tackled from the sphere of specific individual disciplines” (Max-Neef 2005, 5). However, Max-Neef (2005, 6) observes another problematique – “consolidation of academic prestige” – which leads to compartmentalisation of society’s knowledge fund and is the fundamental cause of the wickedness of policy problems and “cluelessness”, as it were, on how best to address the problematiqués. Epistemic power and domination is part of the problematique. However, Max-Neef’s (2005) observation suggests that integrative knowledge systems will provide a long term solution to global/national policy problematiqués. The integrative knowledge systems, as the Club of Rome puts it, must take into account the “**human element**” and never “relegate their impact on human beings to secondary importance” (Botkin et al. 2014, 4, emphasis in original).

Environmental policy, in all its dimensions that include biodiversity policy and climate change policy, is a cross-cutting issue. It has been plagued by the problematique phenomenon not only as nature adversely feeds back in response to human-induced changes, but also as compartmentalisation of knowledge often has increasingly hindered consensual solutions (Hielscher et al. 2012, Petrick and Pies 2007). In many countries and global processes, in general, policies for redressing environmental problematiqués often are framed as natural science processes (Bromley 2012, Degnbol et al. 2006, Haas 1992, Han 2015, Jentoft 2006, Norgaard 2007, Ostrom and Cox 2010, Ostrom and Ostrom 2014, Salmi 2012). However, Bromley (2012, 19) emphasises that nature is a “social construction” and “shared mental objectification” of those who experience its effects. Thus, from a pragmatist’s point of view, people know nature by its effects on them because “[o]ur idea of anything is our idea of its sensible effects” (Peirce 1878, 293). Convergence of mental objectification suggests that it is possible to design consensual institutions, which imply utilisation of multidisciplinary and, better still, transdisciplinary knowledge systems in institutional design.

The South African regulatory reform process for managing alien and invasive species has been contested for nearly a decade, since 2004. The passing of the National Environmental Management: Biodiversity Act of 2004 required the Minister of Environmental Affairs to publish a national list of invasive species that would be liable for eradication. Trout was one such species that was listed as nationally invasive. The controversy between the Department of Environmental Affairs (DEA) and the trout sector continued until 2014 when the Ocean Labs Planning process intervened following the Presidential vision of developing an Ocean Economy. Trout was regarded as a key species in the realisation of the Ocean Economy, through aquaculture development. Eventually, regulations were passed that were supportive of trout

aquaculture. However, our focus is on the period before the intervention of the Ocean Labs Planning process. We ask how reasonable were the contested draft regulations that were designed to manage alien and invasive species. We also ask why the process was highly contested, which helps us to identify things that have to be considered if right institutions are to be designed. To do that, we investigated the perceptions of the trout industry.

Section 2 presents quantitative results obtained from analysing online survey data. The online survey was launched between 14 May and 31 July 2014 to solicit the perceptions of the trout industry, especially trout fly-fishers who for the greater part of the regulatory reform process were actively resistant to some policy proposals, but also actively sought to contribute to policy change constructively. Section 3 discusses the results. Section 4 concludes the paper and draws some policy recommendations.

2. Data analysis

Demographic statistics

Table 1: Summary demographic statistics

Item	mean	Std. dev	median	min	max	Response rate	n
Are you a flyfisher? (yes = 1, no = 0)	.91	.284	1	0	1	100%	114
Are you a clubmember? (yes =1, no=0)	.73	.44	1	0	1	92.1%	105
Sex (female =1, male =0)	.06	.25	0	0	1	92.1%	105
Race (white = 1, other 0)	.99	.10	1	0	1	91.2%	104
Level of education (below matric = 1, postgraduate = 6)	4.78	1.44	5	1	6	91.2%	104
Number of fly-fishing years	23.18	13.57	20	2	60	88.6%	101
Do you own a second home at your favourite fly-fishing destination?	.14	.34	0	0	1	90.4%	103
Salary (less than R10000/month=1, greater than R50000/month=6)	4.07	1.63	4	1	6	89.5%	102

Source: Author's analysis

As Table 1 shows, respondents were predominantly fly-fishers (91%) and 73% were affiliated to fly-fishing clubs. The respondents were predominantly male (94%) and racially white (99%). The average level of education was undergraduate qualification. The average monthly income earned was between R31000 and R40000. About 14% of the respondents owned second (holiday) homes in their fly-fishing destinations. On average, a respondent had spent about 23 years in piscatorial pursuits.

Policy controversies

Table 2 shows that the trout industry, in general, viewed the regulatory process to have failed on democratic imperatives of policymaking. The group evaluated the regulations to be unreasonable. This evaluation largely followed from the perceived failure of the DEA to balance conservation and economic utilisation; failure to consult; failure to justify decisions;

reliance on acontextual global research as opposed to local (contextual) research among others (see Table 2 for details).

Table 2: Summary descriptive statistics of policy controversies

Item	mean	Std. dev	P50	Response rate
What is the sufficient condition for a species to be listed as invasive? (be alien only = 1, be alien, pose ecological threat and causes economic, human health or environmental harm =3)	2.67	.63	3	92%
Given the sufficient condition, are trout invasive? (yes=1, no=0)	.27	.44	0	99%
Trout should be listed as invasive if the benefits of conserving indigenous species exceeds the economic contribution of trout in a given locality (Strongly disagree =1; Strongly agree = 5)	3.35	1.46	4	100%
DEA followed a local research-driven implementation of the NEMBA (Strongly disagree=1; Strongly agree=5)	2.65	1.41	3	96%
DEA conclusively relied on international evidence (Strongly disagree=1; Strongly agree=5)	4.04	1.23	4	100%
AIS regulations were developed in consultation with interested and affected parties (Strongly disagree=1; Strongly agree=5)	2	1.37	1	100%
FOSAF lacks the specialised knowledge to contribute towards AIS regulations (Strongly disagree=1; Strongly agree=5)	1.96	1.28	1	99%
Trust in DEA has increased as a result of NEMBA AIS regulation decision process (Strongly disagree=1; Strongly agree=5)	1.76	1.11	1	100%
DEA has adequately researched the nature of threat posed by trout on indigenous species (Strongly disagree=1; Strongly agree=5)	1.65	1.20	1	99%
DEA has justified to interested and affected parties the rationale for listing trout as invasive (Strongly disagree=1; Strongly agree=5)	1.49	.99	1	100%
DEA has taken responsibility of researching the socioeconomic benefits of trout (Strongly disagree=1; Strongly agree=5)	1.55	1.09	1	100%
Both alien and indigenous species have a permanent place in the ecology of South Africa (Strongly disagree=1; Strongly agree=5)	3.04	1.38	3	99%
Regulations do strike a balance between conservation of indigenous fishes and economic utilisation of trout (Strongly disagree=1; Strongly agree=5)	1.99	1.39	1	97%
Trout fly-fishing is a way of getting intimate with nature	4.74	.60	5	92%
Trout are significant cultural symbols in South African fly-fishing circles (Strongly disagree=1; Strongly agree=5)	4.61	.66	5	93%
Trout are still a significant status symbol in South African fly-fishing circles (Strongly disagree=1; Strongly agree=5)	4.06	1.07	4	93%
AIS regulations address my spiritual, cultural, social, physical, economic and developmental needs (Strongly disagree=1; Strongly agree=5)	1.79	1.17	1	93%
Even if the regulations promote the conservation of indigenous fishes, their livelihood impact should not be neglected (Strongly disagree=1; Strongly agree=5)	2.66	1.33	2	90%
Evaluate the reasonableness of the AIS regulations as at February 2014? (completely not reasonable = 1, very reasonable = 4)	2.06	.60	2	100%

Source: Authors

Reliability analysis

Cronbach (1951) emphasised that measurement-based research must establish the correctness and dependability of the survey instrument. The reliability of the instrument using Cronbach’s alpha was carried out (Cronbach 1951, Maree 2013). Cronbach’s alpha assesses the extent to which a researcher was right in “expecting a certain collection of items to yield interpretable statements about individual differences” (Cronbach 1951, 297).

Table 3: Cronbach’s alpha after excluding irrelevant items

Item	n	Sign	item-test correlation	item-rest correlation	interitem covariance	alpha
Is trout invasive	113	+	0.4984	0.3819	0.2468	0.7972
DEA followed science driven process in AIS regulations	110	+	0.5392	0.4284	0.2409	0.7920
DEA relied on international evidence to list trout	114	-	0.3640	0.2312	0.2624	0.8102
DEA researched nature of threat posed by trout to indigenous fish	113	+	0.5873	0.4828	0.2372	0.7887
DEA researched socioeconomics of trout	114	+	0.6088	0.5066	0.2342	0.7859
DEA consulted when drafting AIS regulations	114	+	0.5987	0.4955	0.2344	0.7861
FOSAF lack specialised knowledge	113	+	0.5855	0.4812	0.2360	0.7876
Trust in DEA increased	114	+	0.7084	0.6247	0.2233	0.7752
DEA justified rationale for listing trout as invasive	114	+	0.7309	0.6525	0.2212	0.7731
AIS regulations strike balance between conservation and economic utilisation	111	+	0.5751	0.4702	0.2387	0.7900
AIS regulations meet NEMA2.2	106	+	0.4794	0.3422	0.2513	0.8011
Even if regulations promote conservation of indigenous fish, their livelihood should not be neglected	103	+	0.4475	0.3092	0.2545	0.8038
Sufficient condition for listing species as invasive	105	-	0.4437	0.3210	0.2510	0.8008
Test scale					0.2410	0.8049

Source: Author’s analysis

Table 3 presents the results of the reliability analysis. Since the items were measured on different scales, the estimation standardised the scale (Gliem and Gliem 2003). The most important column in Table 1 is the column labelled alpha because it reveals the effect on the Cronbach’s alpha of excluding an item. Items for which the alpha is lower than the test scale (alpha = 0.8) are relevant because excluding them lowers the reliability. The converse

maximum likelihood estimates ... which produces estimates that are the most likely to represent the “true” factor scores” (DiStefano et al. 2009, 4-5). The regression scoring method, as an alternative to Bartlett scoring, does not account for bias despite producing maximally valid scores (DiStefano et al. 2009, Gorsuch 1997). The factor loading matrix was then used to determine the items which belonged to a factor. The factors were then assigned names based on the nature of items clustered in them. Using the reduced number of variables, a binary response logistic model was estimated (Williams et al. 2012).

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was used to evaluate the appropriateness of carrying out factor analysis. It determines the proportion of variance amongst the items that represents the common variance. Dziuban and Shirkey (1974, 359) emphasise that the “index yields an assessment of whether the variables belong together psychometrically” in which case the resultant correlation matrix will establish the reasonableness of carrying factor analysis. The rules of thumb are that a KMO of 0 – 0.49 is unacceptable; 0.50 – 0.59 is miserable; 0.60 – 0.69 is mediocre; 0.70 – 0.79 is middling; 0.80 – 0.89 is meritorious and 0.90 – 1.0 is marvellous (Dziuban and Shirkey 1974). Table 2 shows the results of KMO analysis.

Table 4: Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy

Variable	KMO
DEA researched socioeconomics of trout	0.7729
DEA consulted in developing AIS regulations	0.7427
Fosaf lack specialised knowledge to contribute to AIS regulations	0.7414
Trust in DEA increased due to AIS regulations process	0.7854
DEA justified rationale for listing trout as invasive	0.8261
AIS regulations strike balance between conservation of indigenous fishes and economic utilisation of trout	0.6758
Is trout invasive?	0.6190
DEA relied on international evidence to list trout	0.6468
What is sufficient criterion for listing a species as invasive?	0.5683
DEA researched the nature of ecological threat posed by trout	0.8090
AIS regulations NEMA 2.2 needs	0.6873
Even if regulations promote conservation of indigenous fish, their livelihood should not be neglected	0.5325
DEA followed a science driven process in AIS regulations	0.7192
Overall	0.7304

Source: Author’s analysis

While the rest of the items had a KMO measure of sample adequacy in the middling to meritorious categories (Table 4), four items had a KMO in the mediocre category: namely, “regulations strike balance between conservation of indigenous fishes and economic utilisation of trout”, “is trout invasive?”, “DEA relied on international evidence” and “regulations meet NEMA2.2 needs”. Two items had a KMO in the miserable category: chiefly, “even if regulations facilitate conservation of indigenous fishes, their livelihood impact should not be neglected” and “the sufficient criterion for listing trout as invasive.” The poor sample adequacy for some items illustrated the limitations of relying on items

rather than scaled factors in further analysis (Gliem and Gliem 2003, Maree 2013). Nevertheless, the all-items KMO (= 0.73) reported in Table 4 suggests that the sample was adequate.

Exploratory factor analysis results

Exploratory factor analysis was conducted to reduce the data to a few theoretical constructs. Maree (2013, 219) asserts that factor analysis seeks to establish belongingness of items in that those that belong together “measure the same dimension or factor”. Following Maree (2013, 219), “the “bad” items” identified during reliability analysis were “removed”. Oblique rotation was used to assess the underlying pattern for the latent variable such that correlated factors were produced (Gorsuch 1997). DiStefano et al. (2009, 3) have argued that “the cut-off value to use is an arbitrary decision.” The researchers chose a factor loading cut-off value of 0.4, which was above the least recommended cut-off value of 0.3 (DiStefano et al. 2009). All factors with Eigen values that were at least unity were considered (Williams et al. 2012) so as to retain a broader set of factors of theoretical interest. Williams et al. (2012, 9) emphasise that the “labelling of factors is a subjective, theoretical, and inductive process.” Labels aligned with the paper’s “theoretical and conceptual intent” (Williams et al. 2012, 9) were chosen as shown in Table 5.

Four groups of items comprised the four extracted factors (Table 5). The factor loading coefficients in Table 5 are Bartlett coefficients used to estimate the individual scores (per case/row). The column labelled “Uniqueness” measures the variance that is peculiar to a variable. Variables with large uniqueness values were less relevant in the factor model because they had less in common with other variables. For example, 57% of the variance in “DEA researched socioeconomics of trout” was not shared with other variables in the factor model. On the other hand, 28% of the variance in “Trust in DEA increased due to NEM:BA decision processes” was not shared by others, but it was a much smaller proportion relative to 57% for “The DEA researched socioeconomics of trout”. Thus, “The DEA researched socioeconomics of trout” was less relevant in the factor model than “trust in DEA increased”.

The first factor (labelled Participatory) consisted of six democratic policymaking related items such as “The DEA *consulted* when developing the AIS regulations”; “The DEA *justified* the rationale for listing trout as invasive”; and “Trust in DEA increased as a result of the decision processes of the NEM:BA” (Table 5). The most important items in this factor were trust in the DEA increased (factor loading of 0.77), justification of administrative decisions (a factor loading of 0.76), “The FOSAF lacks expertise to contribute to the AIS regulatory reform process” (factor loading of 0.76) and “The AIS regulations strike *balance* between conservation of indigenous fishes and economic utilisation of trout” (factor loading of 0.64). The importance of administrative due process and consensual institutional change was the central thrust of this factor. It is important to note that all the items entailed participatory activities – trust building is an interactive process, justification is an interactive process of giving and asking for reasons, balancing/win-win solutions imply solving the puzzle consensually as is characteristic of wicked problems and researching socioeconomics of trout calls for active interaction between the DEA and the sector.

Table 5: Extracted factors by oblique rotation

Variable	Participatory	Evidence for listing	Anthropocentric	Contextualise	Uniqueness
DEA researched socioeconomics of trout	0.4374				0.5710
DEA consulted in developing AIS regulations	0.5440			0.4967	0.3966
Fosaf lack specialised knowledge to contribute to AIS regulations	0.7602				0.4138
Trust in DEA increased due NEM:BA decision processes	0.7696				0.2834
DEA justified rationale for listing trout as invasive	0.7604				0.3349
AIS regulations strike balance between conservation and economic utilisation	0.6440		-0.4443		0.4195
Is trout invasive?		-0.7665			0.3843
DEA relied on international evidence to list trout		0.5456		0.5437	0.4468
What is sufficient criterion for listing a species as invasive?		0.7252			0.3696
DEA researched the nature of ecological threat posed by trout			0.6577		0.4313
AIS regulations NEMA 2.2 needs			0.7204		0.3978
Even if regulations promote conservation of indigenous fish, their livelihood impact should not be neglected				0.4421	0.4705
DEA followed a science driven process in AIS regulations				0.7222	0.3768

Note: Factors with loadings <0.4 excluded

Source: Author's analysis

The second factor consisted of three items, and this factor was labelled “evidence for listing” (Table 5). The items that loaded in “evidence for listing” were “Is trout invasive?”; “The DEA conclusively relied on international evidence to list trout as invasive” and the “Sufficient condition for listing species as invasive”. The most important item of these three was “Is trout invasive?” (factor loading of -0.77). “Is trout invasive” entered the factor negatively suggesting that as the DEA accumulated evidence of the ecological impact of trout, people tended to regard trout to be invasive. Being regarded as invasive was

associated with a negative connotation of being a “public bad” in some sense. Hence the increase in evidence for listing trout as invasive made it a less desirable species, especially in an ecological sense, thus the negative sign. “The sufficient condition for listing trout as invasive” (factor loading of 0.73) entered the factor positively because the sufficient condition if considered in its broadest sense required the gathering of evidence of ecological impact, human health impact, economic impact and environmental impact. A firm and broad evidence base positively related to the sufficient condition for listing a species as invasive. The variable, “The DEA relied on international evidence to list trout”, entered the factor positively because global research is an important source of evidence although it has to be contextualised before application to local policy problems.

The third factor, labelled “anthropocentric” (Table 5), contained three items: namely, “The DEA researched the nature of ecological threat posed by trout” (factor loading of 0.66); the “AIS regulations address the spiritual, cultural, economic, developmental, psychological and social needs of the policy clientele, that is, NEMA 2(2) needs” (a factor loading of 0.72); and finally, “The AIS regulations strike balance between conservation of indigenous fishes and economic utilisation of trout” (factor loading of -0.44). The negative influence of the variable “AIS regulations strike balance between conservation of indigenous fishes and economic utilisation of trout” suggested that a greater bias towards human welfare in the current generation lost the essence of long term anthropocentrism because it imposed a cost on future generations. On the other hand, a greater bias towards conservation lost the essence of short term anthropocentrism in that it imposed a cost on the present generation. The factor focused on the people-centeredness of environmental governance in South Africa. Addressing cultural, spiritual, developmental, social, economic and psychological needs was anthropocentrism at the core.

Lastly, the fourth factor, labelled “contextualising”, contained the following items: “DEA followed a South African science-driven process in implementing the NEM:BA” (a factor loading of 0.72); “DEA relied on international evidence to list trout as invasive” (a factor loading of 0.54); “DEA consulted with interested and affected parties in developing AIS regulations” (a factor loading of 0.50) and “Even if the regulations facilitate conservation of indigenous species, their livelihood impact should not be neglected” (factor loading of 0.44) (Table 5). The most important variable in this factor was “DEA followed a South African science-driven process in implementing the NEM:BA” suggesting that local research was non-substitutable. It played an important role in shaping policy development and provided the framework for contextualising global evidence (Ellender and Weyl 2014). The factor emphasised the need to contextualise evidence when making regulatory decisions, because reality was socially and contextually constructed through participatory processes (Bromley 2012, Hiedanpää and Bromley 2011, Ostrom and Cox 2010). McCloskey and McCloskey (1994, 372) similarly argue that “knowledge without persuasion of an audience is useless.” Applying evidence without contextualising it, probably, would be the genesis of wickedness of an institutional adjustment problem. Livelihood profiles indispensably define the limits and rate of institutional adjustment.

Logistic regression model

Since the study aimed at evaluating the reasonableness of the regulatory reform process, a logistic regression of the perceptions about the reasonableness of the 2014 draft AIS regulations was estimated. The questionnaire had an item, which stated: “In my opinion,

the National Environmental Management: Biodiversity Alien and Invasive Species Regulations, in their current state, are....” Respondents were to choose from amongst four ordered responses, namely “1= completely not reasonable”; “2=not reasonable”; “3= reasonable”; and “4=very reasonable”. Since the dependent variable was ordered, an ordered logistic regression was used. However, the assumption of proportionality of odds was violated when the ordered logistic regression was estimated, thus suggesting that an ordered logit regression could not be estimated (Long and Freese 2006). Thus, the researchers decided to merge categories of the reasonableness variable. Completely not reasonable and not reasonable were re-coded as “not reasonable = 0” and reasonable and very reasonable were re-coded as “reasonable = 1”. Since the variable became binary, the researchers proceeded to estimate a binary logit model, thus the discussion of binary logistic regression that follows below.

Assuming a latent variable $y^* \in (-\infty, +\infty)$, a structural equation can be expressed as

$$y^* = X\beta + \varepsilon, \quad y = 1[y^* > 0] \quad (2)$$

where ε is a continuously distributed random variable independent of X , with a symmetrical distribution around zero and $1[\cdot]$ is an indicator function. X is a vector of quantitative predictors. The dependent variable assumes a value of 1 as long as the latent variable is positive, otherwise it assumes zero.

$$\Pr(y = 1|X) = \Pr(y^* > 0|X)$$

$$\text{Thus, } \Pr(y = 1|X) = \Pr(X\beta + \varepsilon > 0|X)$$

$$\Pr(y = 1|X) = \Pr(\varepsilon > -(X\beta)|X)$$

$$\Pr(y = 1|X) = 1 - \Lambda(-X\beta)$$

$$\Pr(y = 1|X) = \Lambda(X\beta) \quad (3)$$

The variance of the error term in a logistic distribution is given by $\text{Var}(\varepsilon) = \pi^2/3$.

$$\text{The binary logit can be expressed as } \Pr(y = 1|X) = \frac{e^{X\beta}}{1+e^{X\beta}}.$$

Since y^* is unknown, the magnitude of the estimated coefficients has little value because the objective is not to estimate the effect of each x_i on y^* . Thus, it is the sign of the estimated coefficients that matters. The marginal effect a change in x_i on $P(y = 1|X)$ can be estimated by the partial derivative of

$$\frac{\partial \Pr(y=1|X)}{\partial x_i} = \Lambda'(X\beta) \cdot \beta_i = \lambda(X\beta) \cdot \beta_i \quad (4)$$

Since the cumulative density function for ε in (3) is strictly increasing, it follows that $\lambda(X\beta) > 0$. Thus, the effect of x_i on $P(y = 1|X)$ depends on the sign of β_i . However, (4) measures an instantaneous change in probability, which is likely to be a poor interpretation strategy if there are non-linearities in the relationships of the x_i 's and the probability of perceiving AIS regulations to be reasonable. In the presence of non-linearities, the

alternative is to interpret the effect of discrete changes in both x_i 's on the probability of perceiving the regulations to be reasonable.

Logistic regression results

Table 6 presents the results of the binary logistic model. All demographic variables perfectly predicted the outcome variable except education, which the researcher included in the final model. The effective estimation sample was 86. The model was significant at less than the 1% level of significance with a Chi-squared statistic (=37.64). This suggested that the null hypothesis that all estimated coefficients except the intercept were jointly zero was rejected. Judging by the pseudo R^2 , the model was a good fit because with only five variables it explained over 57% of the total variation in the probability of perceiving the 2014 draft AIS regulations as reasonable. The model made theoretical sense. Exact levels of significance were used to interpret statistical significance of estimates since they are non-arbitrarily determined (Gujarati 2004).

Table 6: Estimation results for logistic regression of Reasonableness of the 2014 draft alien and invasive species regulations

	Reasonableness of 2014 draft AIS regulations (0,1)
Participatory	1.618***
Standard error	.614
P-value	0.008
Evidence for listing	2.837**
Standard error	1.175
P-value	0.016
Anthropocentric	1.934***
Standard error	.723
P-value	0.007
Contextualising	1.652**
Standard error	.695
P-value	0.017
Education	.277
Standard error	.520
P-value	0.594
Constant	-5.766
Standard error	3.187
P-value	0.070
Number of obs	86
Log likelihood	-14.066
LR chi2(5)	37.64
Prob > chi2	0.000
Pseudo R2	0.572

Note: *** means significant at 1%; ** means significant at 5%

Source: Author's analysis

The factor, "participatory", had a positive effect on the probability of perceiving the 2014 draft AIS regulations to be reasonable. The effect was significant at an exact significance

level of 0.8% (Table 6). Béné and Neiland (2006) emphasised that effective participation theoretically entailed four dimensions of equity: chiefly, institutional equity, endowment equity, economic equity and political equity in the policy space. Institutional equity entails a just burden of transaction costs of the institutional change process. Economic equity entails fair access to economic rents derived from the resource. Endowment equity entails fair access to the resource. Lastly, political equity entails participatory equity.

Similarly, the ability to address “anthropocentric” issues facilitated affirmative perceptions about the reasonableness of the regulations. The effect was significant at an exact significance level of 0.7% (Table 6). An evidence-based/evidence-driven (“evidence for listing”) regulatory reform process increased the probability that the respondent would perceive the draft AIS regulations to be reasonable. This positive effect was significant at an exact significance level of 1.6% (Table 6). The founding constitutional provision for environmental governance requires *reasonable legislative* and other measures to be implemented to facilitate progressive realisation of environmental rights (Republic of South Africa Constitution 1996, section 24). Reasonable legislation is that for which there is a rational and defensible causal link between the legislative/regulatory intent, public purpose and the scientific/other evidence available to the legislator/regulator. Lastly, the ability to “contextualise” scientific or other evidence had a positive influence on the probability of the respondent perceiving the draft AIS regulations to be reasonable. The effect was significant at an exact significance level of 1.7%.

The model was tested for goodness of fit and it correctly predicted 91% of the cases. Thus, it was a judged to be a good fit. However, Greene (2003) argues that percent correctly predicted is a poor measure of goodness of fit because if one of the binary outcomes excessively dominates the other, the proportion correctly predicted will always be high. For example in the current sample, nearly 86% of the respondents stated that the regulations were not reasonable. It means that the model had a guaranteed 80% or more of correct predictions from the onset. Table 7 presents transformed results derived from Table 6 for ease of interpretation. Only significant variables are reported.

Table 7: Interpreting odds

Reasonableness of 2014 draft AIS regulations (0,1)	Coeff	z	P> z	% change in odds for a unit increase in X	% change in odds for SD increase in X	Standard deviation of X
Participatory	1.618	2.633	0.008	404.3	410.4	1.0075
Evidence for listing	2.837	2.415	0.016	1606.4	1644.5	1.0078
Anthropocentric	1.934	2.675	0.007	592.0	600.0	1.0059
Contextualising	1.652	2.377	0.017	421.6	414.6	0.9918

Source: Authors

Participatory

For a unit increase in the factor “participatory”, the odds of perceiving the regulations to be reasonable increased by just over 404%, holding other factors fixed at their means (Table 7). Similarly, a one standard deviation increase in the factor “participatory” increased the odds of perceiving the regulations to be reasonable by just over 410%, all variables centred on their means. This result suggests that satisfying democratic environmental policymaking

requirements has a strong positive influence on the evaluation, by the polity, of the reasonableness of the proposed institutional arrangement.

Evidence for listing

A one unit increase in the factor “Evidence for listing” increased the odds of perceiving the regulations to be reasonable by just over 1606%, holding other factors fixed at their means (Table 7). The odds of perceiving the regulations to be reasonable increased by nearly 1645% for a one standard deviation increase in the factor “Evidence for listing”, all variables centred on their means. Thus, the factor “Evidence for listing” was the most critical in shaping the perceptions of the reasonableness of the regulations because its effect on the magnitude of the change in the odds of perceiving the regulations to be reasonable was at least 2.5 times the effects of changes in the other factors. The implication is that a regulatory reform process that was perceived to be evidence-driven was perceived as a reasonable process of institutional change.

The findings suggest that there are increasing returns to investment in aquatic fish invasion research because the resultant evidence has the potential to create positive perceptions about the reasonableness of regulatory change proposals, which in turn would minimise transaction costs of environmental policy (McCann 2013, Coggan et al. 2010, Mettepenningen et al. 2011, Mettepenningen et al. 2009). Usually, transaction costs of environmental policy are magnified by controversy-driven vicious planning circles that fail to resolve the problem, which, often, are contestations over evidence used to make decisions. Repeated planning circles involve resources such as time, personnel, funds and hiring consultants among others. Evidence is crucial to consensus building, which is a sure way of addressing wicked problems (Balint et al. 2011, Rittel and Webber 1973). Similarly, evidence-based institutional change enables policymakers to give reasons and justify actions satisfactorily to private agents (Brandom 1995, Davidson 1963, Hiedanpää and Bromley 2011, Price 2013), thus reducing private transaction costs of lobbying and litigation since reasonable beings are likely to be satisfied that the proposed institutional change is credible (Mettepenningen et al. 2009).

Reviewing the state of South African knowledge about freshwater alien fish invasions, Ellender and Weyl (2014, 125-128) emphasised:

“Research on the invasive impact of fishes in South Africa is in its *infancy*... The effective implementation of IAS legislation will require a *strong information base* to allow for proactive decision making and allow for *comprehensive* risk assessments based on *regional experience*. The current literature review indicates that South Africa is *data-poor* with regard to understanding non-native fish invasions” (emphasis added).

This argument suggests that currently the AIS regulatory reform process might be suffering from inadequate contextual (local/regional) scientific information about the invasiveness of some alien fish. If this argument follows, and it is the most recent review of the state of South African knowledge about invasiveness of alien fish, then the present findings are corroborated. However, some recent studies established the ecological impact of trout (Karssing et al. 2012, Rivers-Moore et al. 2013, Shelton et al. 2014). A common feature of these studies is that they focus on the impact of trout in the invaded area, but they do not examine other dimensions of invasion such as availability of potentially colonisable habitat

and the species' historic and innate rate of range extension, which scholars such as Macdonald and Jarman (1985) and Richardson and Van Wilgen (2004) considered to be the most important. Ellender and Weyl (2014, 128) also emphasise this knowledge gap stating that “relatively little research has been done on their introduction, establishment and spread” (emphasis added).

Anthropocentrism

Attending to the needs and interests of people equitably and putting them at the forefront of policy processes for managing the environment defines the core of the anthropocentric South African constitutionalism. A unit increase in the factor “anthropocentric” increased the odds of perceiving the regulations to be reasonable by 592%, holding other factors fixed at their means (Table 7). For a one standard deviation increase in the factor “anthropocentric”, the odds of perceiving the AIS regulations to be reasonable increased by 600%, all variables centred on their means (Table 7). This result is interesting in the sense that the definition of an invasive species in the NEM:BA has an ecological threat component as well as harm to human health, economic harm and environmental harm components. Thus, to list trout as invasive without demonstrating its threat to the human condition or liveability of the environment necessarily generated objections.

The factor, “anthropocentric”, was largely dominated by the NEMA section 2(2) provision that environmental governance must put people at the forefront of its concern and address their spiritual, psychological, developmental, cultural, economic and social needs (factor loading of 0.73), which is anthropocentrism. The other dominant factor was “DEA researched into the nature of ecological threat posed by trout on indigenous species (factor loading of 0.66),” but the general perception was that the DEA did not research the matter sufficiently. This implies that if the DEA had adequately researched the nature of the threat, a more human-oriented regulatory proposal than the current proposal would have been attained. The South Africa constitutional/NEMA environmental governance framework is consequentialist, which logically is human-centeredness.

Contextualising

The results in Table 7 also reveal that the odds of perceiving the regulations to be reasonable increased by nearly 422% for a unit increase in the variable “contextualising”, holding other variables fixed at their means. A one standard deviation increase in “contextualising” also increased the odds of perceiving the regulations to be reasonable by nearly 415%, all variables centred on their means. This was an enormous influence, which was dominated by the item “the DEA followed a South African scientific research-driven process in implementing the NEM:BA” (factor loading of 0.72), and suggested that scientific evidence was a necessary condition for a new institution to be perceived to be reasonable. Scientific claims are warranted assertions that are yet to become valuable assertions after democratic valuation (Bromley 2004, Bromley 2008). Thus, the extent to which regulations were perceived to be reasonable depended on the extent to which the DEA carried out scientific research on invasions and depended on the contextualisation of scientific evidence to South Africa bio-climatic conditions in deciding the listing of species.

The foregoing conclusion follows given the presence in “contextualising” of aspects such as international evidence, consulting interested and affected parties in developing regulations and livelihood impact of regulations. All these items not only define and shaped the context

within which scientific claims are transformed into new institutions, but also determine the extent and speed of institutional adjustment. They are limiting factors to what a scientist would naturally propose as the perfect solution; for example, eradication of an alien and invasive species is a natural solution for many invasion ecologist (Selge et al. 2011).

Assessing changes in probability

Table 8 shows that the probability of perceiving the regulations to be “not reasonable” was 98.8%, all factors held at their means. Table 8 reveals that as “participatory” increased from its minimum to its maximum, the probability of perceiving the regulations to be reasonable increased by 0.9 (or $\frac{0.9032}{0.0011} \times 100 = 82\ 109\%$), holding other variables at their means.⁵ Thus, the probability of perceiving the regulations to be reasonable was very sensitive to the state of participation of resource users in environmental governance.

Table 8: Changes in probabilities for reasonableness

	from	to	diff	from	to	diff	mfx
	X=min	X=max	Min->Max	x-0.5sd	X+0.5sd	-+0.5sd	
Participatory	0.0011	0.9043	0.9032	0.0055	0.0276	0.0220	0.0198
Evidence for listing	0.0000	0.2658	0.2658	0.0030	0.0498	0.0468	0.0347
Anthropocentric	0.0001	0.8914	0.8913	0.0047	0.0321	0.0274	0.0237
Contextualising	0.0004	0.6101	0.6098	0.0055	0.0277	0.0222	0.0202
Probability that February 2014 AIS regulations were not reasonable							0.988
Probability that February 2014 AIS regulations were reasonable							0.012

Source: Authors

The probability of perceiving the regulations to be reasonable also was very sensitive to the manner in which anthropocentric issues were addressed because it increased by 0.9 (or 891 300%) as “anthropocentric” switched from its minimum to its maximum, holding other factors at their means (Table 8). Similarly, the probability of perceiving the regulations to be reasonable was sensitive to the increase in “contextualising” from its minimum to its maximum (increasing by 0.6 or 152 450%), holding other variables at their means. As “Evidence for listing” increased from its minimum to its maximum, the probability of perceiving the regulations to be reasonable increased by 0.3 (or nearly infinite %) holding other variables at their means, which was a very large influence. One could also interpret the results in terms of marginal effects and standard deviations, but for economy of space, we exclude that interpretation here.

What is evident from the foregoing analysis is that the probability of perceiving the regulations to be reasonable was sensitive to the availability of evidence for listing species as invasive. While analysing the odds of perceiving the regulations to be reasonable it was shown that the effect of a one unit increase in “evidence for listing” on the odds of perceiving the regulations to be reasonable was at least 2.5 times the effects of one unit

⁵ % change = $\left(\frac{\text{probability at maximum} - \text{probability at minimum}}{\text{probability at minimum}} \right) \times 100$

increases in other variables (Table 7). Overall, all the factors had huge influences on the changes in the probability of perceiving the regulations to be reasonable.

3. Discussion

Scholars in natural resource governance have severally come to the conclusion that sustainable and effective natural resource governance requires resource users to play an important role in the design of institutions that affect them (Bromley 2012, Degnbol et al. 2006, Haas 1992, Han 2015, Jentoft 2006, Norgaard 2007, Ostrom and Cox 2010, Ostrom and Ostrom 2014, Salmi 2012). However, the paper showed that effective participatory governance might not have occurred. Béné and Neiland (2006, 45) argue that democratic policymaking facilitates “economic equity” (“equity in rent redistribution”), “institutional equity” (fair burden of transaction costs imposed by the regulatory framework), “political equity” (“equity of participation in decision-making process”) and “endowment equity” (“equity of access” to environmental resources). These factors largely relate to administrative due process in the processes of institutional change.

Processes that fail to provide for participatory governance have been described as “painting the floor with a harmer” and “technical fixes” (Degnbol et al. 2006, 534). Ostrom and Cox (2010) have also called them panacea problems because they offer deterministic solutions. Bromley (1985) discusses them as the myth of management, because knowledge of groups socially embedded in the resource system is marginalized. Han (2015) discusses them as environmental authoritarianism. To the extent that the regulatory reform process was influenced by ruling down approaches, it is not surprising that the trout industry perceived the regulations to be unreasonable. They tended to be “imbecile institutions” that sought to disrupt the development of the human life process and culture (Veblen 1914, 25).

From an institutional design perspective and being mindful of the wickedness of managing socially, culturally and economically invasive species, non-participatory governance process reduce the potential for creativity in institutional design. The problem is that the institutional design process becomes a win-lose game (Hielscher et al. 2012). Faced with a well organized and powerful social group such as the trout industry, the tendency of for the governmental agency is to push the policy process into several cycles of fruitless planning. The amount of wasted economic resources in the form of transaction costs of environmental policy becomes enormous. Such cycles of planning, result in the emergence of a planning curse. A planning curse merely implies that large amounts of economic resources (time, money and human resources) are utilised with little social returns in the form of reasonable institutions that are facilitative of sustainable development. Thus, Hielscher et al. (2012) and Petrick and Pies (2007) argue that a process of collective self-damage evolves because the transaction cost burden is borne by both government and the private agents. In essence, collective self-damage suggests the existence of an impoverishing Nash policy adjustment path and equilibrium. Figure 1 illustrates this argument.

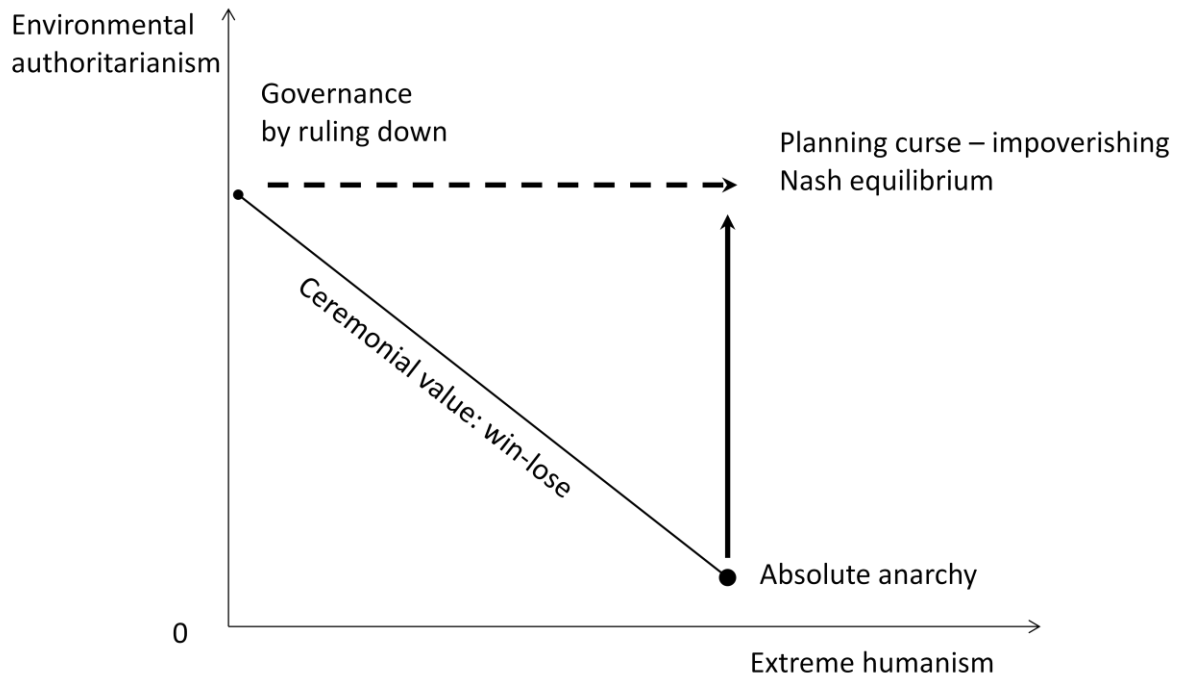


Figure 1: Win-lose policymaking paradigm as a prisoner's dilemma

Source: Authors' analysis

As can be seen from Figure 1, for as long as the policymakers fail on participatory environmental governance, the tendency is to marginalise the interests of the resource users (Hiedanpää and Bromley 2011; 2014). The problem is compounded when the resource users also pursue their selfish interests in a way that makes design of reasonable institutional arrangements impossible. From a Veblenian Dichotomy perspective, one could argue that both the administrators and the resource users are pursuing ceremonial interests (Bush 1987; 1989, Marire 2015). Ceremonial interests serve selfish interests of the social group or governmental agency concerned. The conflict of ceremonial interests sits at the heart of the planning curse, wicked problems and institutional design pathologies and, often, results in zombie institutions (Ayres 1996, Hielscher et al. 2012, Marire 2015). The institutional design policy game is designed as a non-cooperative game – as a win-lose paradigm (Hielscher et al. 2012, Petrick and Pies 2007). It is a prisoner's dilemma game. Wicked problems tend to result in impoverishing Nash equilibriums if they are approached from a non-participatory perspective (Hartmann 2012, King 1993, Rittel and Webber 1973).

An impoverishing Nash equilibrium corroborates the concept of imbecile of institutions. Bromley (1985) gives a typical example of a win-lose paradigm of institutional design, which is very common in most developing countries and is buttressed by the myth of management. He states that a

“number of countries passed laws that prohibited the cutting of firewood – apparently in the belief that the 70-90% of their citizens who relied on firewood for the preparation of meals would immediately acquire a taste for raw meat, hard rice, and cold coffee” (Bromley 1985, 790).

The point here is that while environmental conservation is inevitable and most desirable, it takes place in a socio-cultural context in which the environmental resource has multiple meanings to various social beings and groups depending on their situatedness in that environment. The problem here is one of institutional change that not only endangers people's livelihoods because it is misanthropic, but also threatens the continuity of culture.

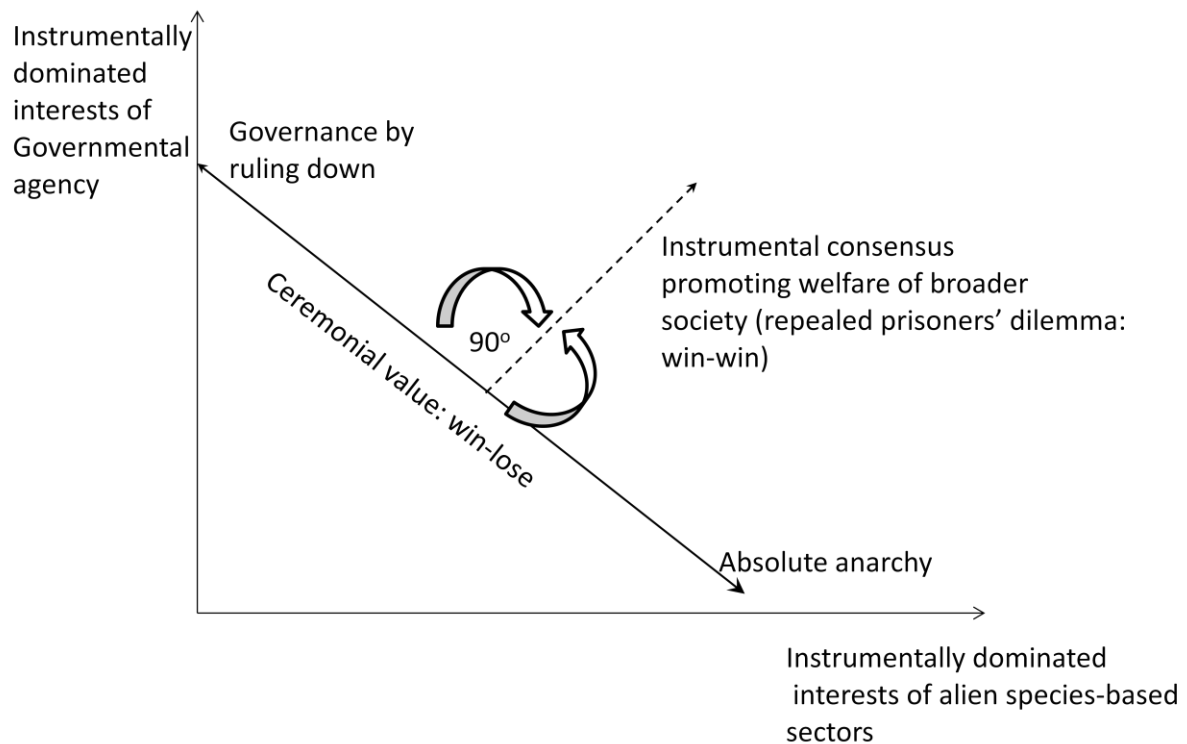


Figure 2: Win-win policymaking paradigm as an assurance game

Source: Authors

The paper's findings suggest that being able to attend to participatory natural resource governance; not neglecting the human element (anthropocentric issues) as the Club of Rome puts it; basing policy design on inclusive evidence – not just that which supports the interests of the regulators; and contextualising international evidence together transform a win-lose institutional design paradigm into a win-win paradigm (Hielscher et al. 2012, Petrick and Pies 2007). The essence of the results of the paper is that attending to these four tenets would have helped the DEA to identify common interests rather than points of difference. Using ordonomics, which investigates the “interdependencies between institutions and ideas”, Hielscher et al. (2012, 780-781) argued that “habits of thought implicated in ... progressive institutional change have a cooperative, rather than a conflictual, nature.” The ordonomic framework seeks to investigate rule configurations that make possible the transition from the “win-lose paradigm” to the “win-win paradigm” “that focuses on joint rule-interests”, which makes “peaceful progressive institutional change ... possible” (Hielscher et al. 2012, 781-782). The transition, however, has varying degrees of the likelihood of success; some transitional phases relapse to the win-lose paradigm, while others progress to the win-win paradigm. Figure 2 illustrates the argument.

The idea behind Figure 2 is the orthogonal transformation of the win-lose institutional design framework into a win-win institutional design framework. It is the conversion of a prisoner's dilemma game into an assurance game. The problem becomes a cooperative/assurance policy game in which parties can choose to realise as much of the instrumental (consensual) outcomes as are possible, while restraining ceremonialism (points of ideological differences) to its bare minimum. It entails meticulous attention to the details of the puzzle policy problem. Integrative and inclusive knowledge systems achieve that by creating "semantic innovations [that] open up new trajectories of social evolution via orthogonal positions" (Hielscher et al. 2012, 794). Semantic innovations, as it were, create social DNA. Social DNA can only be generated when, as Ostrom and Cox (2010, 451) put it, institutional design "overcome[s] historical academic divisions between ecology, engineering and the social sciences." Non-participatory policymaking and unidisciplinary policymaking combine to impoverish society by undermining innovativeness in institutional design (Allen and Gunderson 2011, Hiedanpää and Bromley 2014).

4. Conclusion

The paper evaluated the process of institutional change in South Africa for sustainable biodiversity governance. The draft regulations were found to be imbecile institutions, by virtue of the constraints the regulatory process placed on the regeneration social DNA. The lack of reasonableness lied in the DEA's failure to engage in "effective" participatory environmental governance, contextualisation of global scientific evidence, a seemingly exclusive attention to ecological facts to the marginalisation of the anthropocentric matters and infancy of the evidence base, which was considered unidisciplinary in nature. However, the paper's findings are subject to a caveat that the sample gave the perceptions of the trout industry which, probably, exaggerated the unreasonableness of the regulations. However, the ultimate result in the institutional design process after the intervention of the Ocean Labs planning process in 2014 resulted in the solution that has always been advocated for by the trout industry: a solution that sought to establish sustainable compromises in the management of economically useful alien and invasive species. Future studies can focus on measuring the transaction cost burden imposed on the fiscus and private agents by institutional design pathologies.

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