Expert advice on climate policy and effects of fake advice.

Abstract.

Climate change is complicated. Previous laboratory experiments have revealed severe misperceptions that make people believing in climate change, favor wait and see policies. Judged by similar resource problems, wait and see policies will cause climate to overshoot what is currently seen as the largest acceptable change. Adding expert advice to an earlier laboratory experiment, we find that expert advice can lead to nearly perfect decisions. Of great concern, however, we also find that fake advice that corroborates natural misperceptions, nearly nullifies the effect of proper expert advice. Since the world is on a path towards climate overshoot, paving the ground for appropriate expert advice is very important.

Keywords: expert advice, fake advice, misperceptions, renewable resources, heuristics, management, system dynamics

Introduction.

Even though the climate problem is complicated, in most countries, the majority now believes that human activity can cause climate change (Maibach et al. 2014). However, majorities still opt for wait and see strategies (Sterman and Sweeney 2007, Moxnes, 2009 #4540, Sterman, 2011 #4802, Guy, 2013 #4983, Sterman, 2008 #4651). Therefore, early and continued abatement of emissions relies on expert advice regarding policy options to limit climate change. Consequently, we first ask, can expert advice help people give up on wait and see strategies and instead favor proactive policies?

The case of tobacco shows that expert advice can be challenged by fake “expert” advice (Diethelm and McKee 2009; Oreskes and Conway 2010). To protect short-term commercial interests, the tobacco industry denied the negative health effects of smoking, and inflicted suffering on people that acted on their fake advice. Similar to the tobacco case, the climate debate also experiences fake advice that is contrary to well established science. Next, we ask, is it likely that real expert advice is undermined by fake advice?

To shed light on these two questions we make use of a laboratory experiment where we supply expert and fake advice. However, this is not straight forward. Much advice regarding the climate problem, real and fake, is already known in the pool of potential subjects. Therefore, we make use of an analogous case where the participants have no prior knowledge of existing expert advice. The analogous case is reindeer management, for which previous laboratory experiments and historical data witness the reliance on wait and see strategies, with, at times, disastrous long-term consequences (Moxnes 1998, Moxnes, 2004 #4107).

Our experiment differs from previous experiments examining wait and see strategies (Moxnes 1998; Moxnes 2004; Sterman and Sweeney 2007; Sterman 2011; Guy et al. 2013) in that we provide written advice about what *actions* to take. We do not examine advice given by other participants in the experiment (Swol and Sniezek 2005), and we do not examine consensus formation in groups (Janis 1972; Turner and Pratkanis 1998). Focus is simply on the effect of advice on decision-making by subjects who are in full control of a natural resource, for which there should be no doubt that human activity has an effect. This is a different focus than that of other investigators (Brulle et al. 2012; Kahan et al. 2012), who have studied factors explaining people’s climate concerns and perceived risks. With this focus, Brulle et al. (2012) find that popular science, media coverage, and partisan battles affect the level of public concern. It seems appropriate to assume that scientific expert advice influences all these intermediaries. In the other direction, Brulle et al. find that roll-call votes by climate sceptic Republicans diminished people’s concerns. The climate sceptic Republicans may be influence by fake advice, and they may serve as fake advisors through their voting. According to Fishbein and Ajzen (1975; 1991), concerns and perceived risks can motivate intentions, while behavior may be hindered by (mis-)perceived behavioral control; which is in focus in this study.

In the present experiment we find that expert advice helps people make better decisions. However, fake advice strengthens the natural tendencies to opt for wait and see policies, counteracts expert advice, and leads to results that are not significantly different from the case with no expert advice. We also compare two different types of expert advice, in the words of either an *analyst* or an *activist*. For participants that do not have a minimum of familiarity with the analyst language, the activist wording tends to be the more effective.

First, we present the nature of the decision problem and argue that the climate problem is analogous to a reindeer management problem, and we analyze observations of overshoot and collapse behaviors. Then we present the experimental design, the results, and finally we discuss implications of the findings.

2. Problem definition and reindeer analogy

Climate change is a problem for the long run. When current policies are not sufficient to prevent temperatures from exceeding 1.5 or 2.0℃, one explanation is that people do not care about the long-term. However, research suggests that people are concerned (Maibach et al. 2014), and do not intend to discount the future (Moxnes 2014). A more likely explanation is that people believe in the appropriateness of wait and see strategies. This is a reasonable strategy if one has the means to solve problems after they have occurred. However, research shows that people tend to underestimate what it takes to correct evolved imbalances, for instance restoring depleted natural resources (Moxnes 1998; Moxnes 1998; Sterman and Sweeney 2007; Guy et al. 2013). Moreover, while existing problems get much attention (Dörner 1996), people get little credit for proactively solving problems that have not yet manifested themselves (Repenning and Sterman 2001).

Figure 1 illustrates the structure of an unsuccessful wait and see strategy. On the left-hand side is a model of filling a lower funnel with a narrow outlet with water that flows from a faucet through an upper funnel. When starting to fill the lower funnel, the person in charge focuses on the upper funnel, to avoid that it flows over and to ensure that it has sufficient water to enable a rapid flow into the lower funnel. A wait and see strategy implies that as the water in the lower funnel approaches the desired level, attention shifts to the lower funnel and the faucet is turned down. At this point in time, however, an excessive amount of water in the upper funnel will make the lower funnel flow over.

The middle section of Figure 1 shows a simplified structure for the climate problem. At the outset, there is only one apparent difference from the water funnels, there is no direct flow from the upper to the lower stock. However, the upper stock still influences both the outflow from the upper stock and the inflow to the lower stock. Hence, the structures are still similar.

Emissions of greenhouse gases (GHGs) follow from the global production capacity that emits GHGs. In the fossil energy age, production has enabled ever larger investments in new capacity. This reinforcing feedback loop has enabled exponential type growth in production and emissions. Attention has been directed towards investments, technological development, employment, and growth of the upper stock, while the accumulation of GHGs has been unnoticed or has not represented a pressing problem.

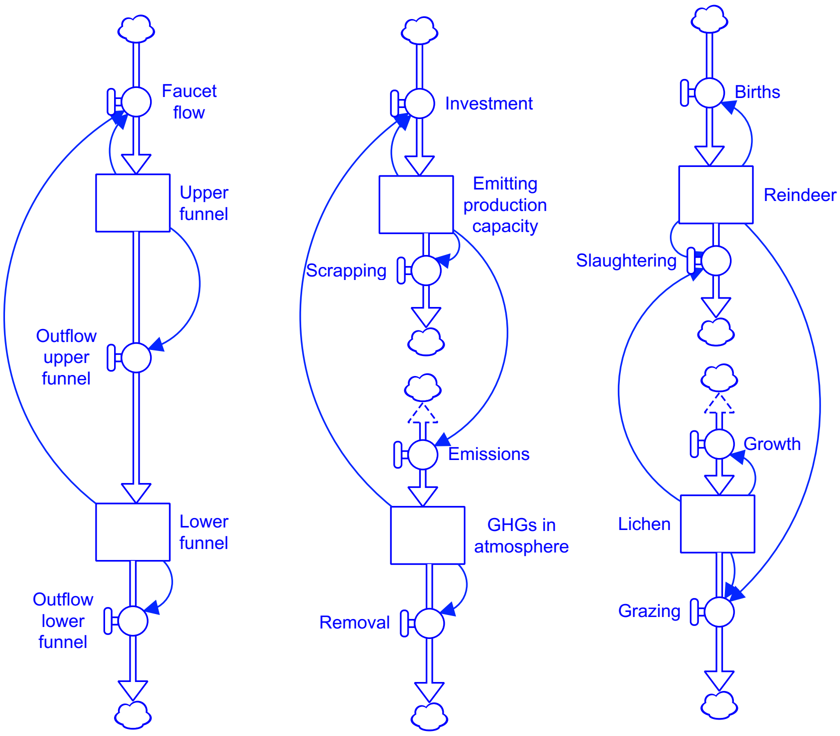

Figure 1: Funnel-funnel and reindeer-lichen analogies to the climate problem. Rectangles denote stocks, thick arrows with a circle denote in- and outflows, thin arrows denote instantaneous cause and effect relationships (arrows denoting decisions are on the left-hand sides of stocks and arrows denoting system effects are on the right-hand sides). Small "clouds" denote sources and sinks outside of the model boundary.

Currently, total emissions are about 100 percent higher than the removal rate for GHGs. If decision-makers realize that the amount of GHGs in the atmosphere must be stabilized or reduced at this point in time, the emissions must be reduced by 50 percent just to stop the growth in atmospheric GHGs. Similar to the funnel analogy, an overshoot in the lower stock, the amount of GHGs in the atmosphere, is likely. This is so because emissions cannot be reduced overnight, they will increase as long as investments in emitting capacity exceeds scrapping of old capacity. Even in the unrealistic case that all investments were banned overnight, emissions would only decrease gradually over decades as existing capacity is worn out and scrapped. Hence, it will take a long time before emissions are reduced by more than 50 percent and become lower than the removal of GHGs. In the meantime, the stock of GHGs in the atmosphere will increase and so will global temperatures. This illustrates the importance of introducing alternatives to emitting production capacity long before climate change has reached an unacceptable level. It also illustrates the folly of wait and see strategies.

The right-hand side of Figure 1 shows a reindeer management analogy. Compared to the climate structure, there are two major differences. Decisions influence the outflow and not the inflow of the upper stock, and the upper stock influences the outflow of the lower stock rather than the inflow. The number of reindeer increases with births and is controlled and reduced by slaughtering. A clever reindeer owner shepherds his herd to ensure survival of the calves, and he keeps slaughtering down, to have plenty of reindeer for a rainy day. Lichen, the vital food resource during the winter, is usually not much of a concern. It is a perennial plant, that is not quickly depleted.

Lichen increases with growth and is reduced by reindeer grazing. In the long run, the growth rate for lichen is a limiting factor for the number of reindeer. Lichen growth is not easily observed and varies from year to year depending on precipitation, sunshine, and the amount of lichen. Since the number of reindeer causes an outflow of lichen, one should expect an undershoot in lichen as opposed to an overshoot for the stock of GHGs.

To simplify the reindeer management task, it is tempting for decision-makers to opt for a wait and see policy, where slaughtering is adjusted according to the perceived amount of lichen rather than to the largely unknown growth rate for lichen. With a wait and see policy, focus is shifted to the amount in the lower stock when it becomes clear that lichen approaches exhaustion. Then it will take a drastic and immediate reduction in the number of reindeer to reduce grazing below the growth rate, which is very low for a depleted lichen stock.

As will be seen later, participants in laboratory experiments are not alarmed as long as the amount of lichen seems adequate. When this is no longer the case, they reduce the number of reindeer gradually and much too late to avoid excessive depletion of lichen.

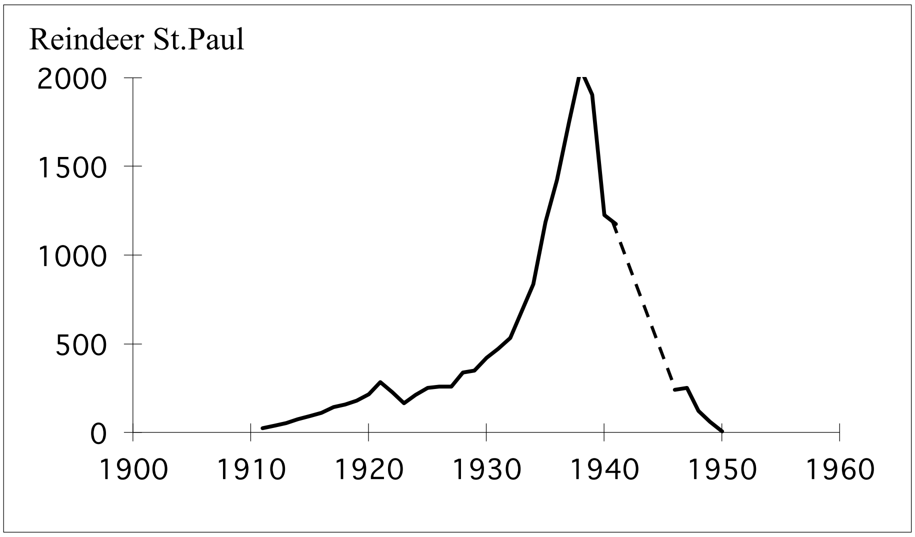

Figure 2: Number of reindeer on the St. Paul Island in Alaska. During World War II, all inhabitants were evacuated and the herd was not counted, source Scheffer (1951).

Overgrazing of lichen is not only a problem in laboratory settings. Figure 2 shows an overshoot and collapse development for the number of reindeer at the island of St. Paul in Alaska. According to Scheffer (1951): 25 reindeer were imported in 1911, the number of reindeer was reported with high accuracy; lichen was not systematically measured but was reported as “practically gone” by 1942; there was only one herd and this herd was co-managed by the inhabitants of the island, hence, there was no tragedy of the commons (Hardin 1968). Scheffer also adds that this was not the only case of overgrazing. He refers to the American Society of Mammalogists that in 1950 warned about “serious problems of integrating lichen ecology, reindeer biology, and native culture - serious problems that have not been solved to date on any workable scale on the North American continent.”

Figure 3 shows data for reindeer and lichen for the Snøhetta area in Norway. Again, there was no “tragedy of the commons” since the number of reindeer was regulated by the government. Already in the early 1950s a rapid decline in lichen should have warned decision-makers that grazing was exceeding lichen growth by a wide margin. However, contrary to a logical policy, the number of reindeer was increased by another 20 percent. In the early 1960s, decision-makers perceived that the lichen had reached a very low level and started a gradual reduction in the number of reindeer. It must have been frustrating to see that lichen continued to drop in pace with increasingly more drastic reductions in the number of reindeer. According to the model in Figure 1, this should not come as a surprise since reindeer grazing started out at more than twice the rate of lichen growth. However, people tend not to think in terms of stocks and flows (Sweeney and Sterman 2000). An earlier reindeer experiment revealed that even experienced reindeer herders expect the amount of lichen to move in the opposite direction of grazing, irrespective of the gap between grazing and lichen growth (Moxnes 2000).

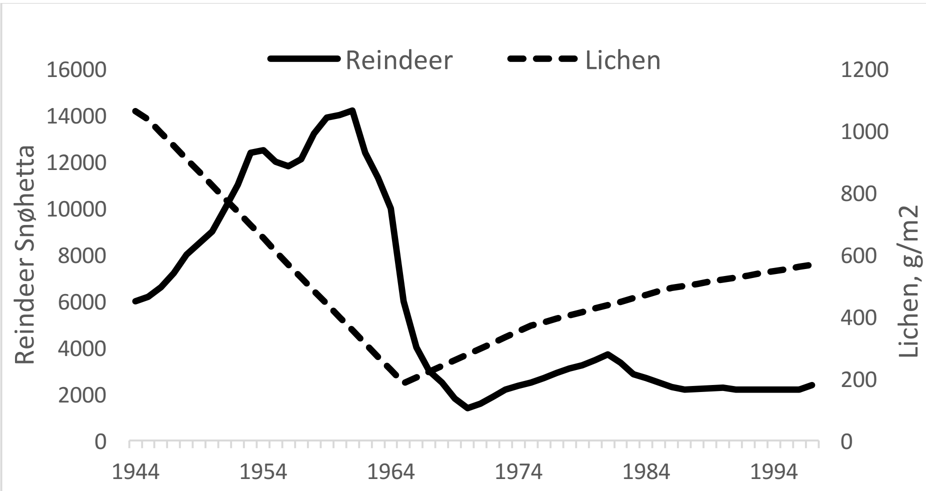

Figure 3: Number of reindeer and interpolated lichen thicknesses between infrequent data points for the Snøhetta area in Norway. Source Moxnes et al.(2003).

The reindeer analogy also works for fisheries. A laboratory experiment with fishers, governmental regulators, and marine scientists produced overshoots in fishing capacity (the upper stock) and undershoot in fish biomass (the lower stock) for all groups of participants (Moxnes 1998). Again, the tragedy of the commons was ruled out by the experimental design (private property rights). The commons problem is normally seen as the cause of depletion of fish resources around the world. However, overinvestment and overfishing has also taken place in regulated waters, for instance after the introduction of the 200 miles economic zones (Schrank 2003). The most blatant sign of misperception is the widespread use of subsidies to ensure profitability in times of overcapacity.

The above discussion suggests that there are strong similarities between reindeer and climate management. Since the reindeer problem is largely unknown in our subject pool, it is better suited than the climate problem itself to test the effects of expert advice. The many examples of overgrazing of lichen, and also overexploitation of fish resources, suggest that the climate problem is more challenging than most people realize. Expert advice is needed to correct or counteract the misperceptions people have about the need for policy interventions at an early stage.

3. Experimental design

To study effects of advice, we use a well-established reindeer management experiment (Moxnes 2004). Laboratory experiments of decision making have revealed widespread misperceptions of nonlinear dynamic systems (Sterman 1989; Sterman 1989; Funke 1991; Brehmer 1992). Notably, many of these experiments concern renewable resources (Moxnes 1998; Brekke and Moxnes 2003; Moxnes 2004) where mismanagement takes place without the tragedy of the commons. Typically, these experiments provide participants with background information and then leave analysis and decisions to the participants themselves. Brief information interventions to help participants analyze, have shown mostly poor results (Brekke and Moxnes 2003 ; Moxnes and Jensen 2009; Moxnes and Saysel 2009).

The advice given in the present experiment is different from information given in earlier studies. Here, the advice is not primarily meant to aid the analysis, rather it says what decisions subjects should make in the short run. This is the type of advice that is feasible to give in short meetings or in political debates. In addition, we present a similar fake advice, which is contrary to well established scientific knowledge, rather consistent with natural misperceptions.

Participants in the experiment are told that they are about to take over the management of a reindeer herd after a period in which the previous owner has increased the herd size with reduced amounts of lichen as a consequence. The instructions, see Appendix A, provide exact reindeer and lichen data for the historical period. The instructions also make clear that each participant has exclusive rights to a limited land area (private property rights). The task is to reach the maximum sustainable herd size as quickly as possible. The participant with the best performance in each session was promised a symbolic prize (Bolle 1990).

In earlier reindeer experiments, simulators were used where both reindeer and lichen were represented by stocks (Moxnes 1998; Moxnes 2004), as depicted in Figure 1. However, the most recent of these studies showed that most of the mismanagement was captured by a simplified simulator where reindeer was not modelled as a stock. Accordingly, a design was chosen where reindeer could be set freely from year to year[1]. Since the two-stock simulator produced deeper depletion and more frequent extinction of lichen than a simulator with only one lichen stock, the present experiment is likely to underestimate the severity of the overgrazing problem (Moxnes 2004). Still, the reindeer experiment serves as an appropriate analogy for the climate problem since climate experiments have found that even highly educated participants have problems dealing with a one-stock model for GHGs (Sterman and Sweeney 2007; Moxnes and Saysel 2009).

The present simulator has the following equation for lichen, measured in average height of the plants

$$L_{t+1} = L_t + G_t - H_t, \quad L_0 = 24.4 \text{ mm} \qquad (1)$$

where the yearly growth of the lichen is given by a surplus growth curve

$$G_t = M\left\{1 - \left[\frac{L_t - C/2}{C/2}\right]^2\right\} \qquad (2)$$

Here M = 5 mm/year is the maximum sustainable yield (average yearly growth) for the lichen. C = 60 mm is the carrying capacity. Reindeer grazing per year

$$H_t = hR_t \qquad (3)$$

is given by yearly grazing per animal h = 0.004 mm/reindeer/year. Finally, R_t is the number of reindeer.

Over a 15-year period, participants receive information about the amount of lichen in the preceding year and make decisions about the number of reindeer R_t for the coming year.

There are three main treatments:
1. Instructions and no expert advice
2. Instructions and expert advice
3. Instructions and expert advice together with fake advice

We hypothesize that expert advice will have a positive effect since the participants do not have previous experience and knowledge about reindeer management. This means

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[1] When analysing decision rules, Moxnes(2004) found that decisions on the number of reindeer anchor on a mental account of the number of reindeer in recent years. Hence, even in the simplified model, the more reindeer one has at one point in time, the stronger depletion of lichen will be at a later point in time.

that the subjects do not have to give up prior and cherished ideas, they do not have to defend what has happened historically, and they do not have to struggle with preferences for the status quo, as for instance in the case of smoking. We consider the experiment exploratory when it comes to the effect of fake advice. The fake advice is designed to reinforce natural misperceptions and should not be expected to have a strong effect in isolation. The effect of fake advice in combination with expert advice is likely to depend on how helpful and convincing the expert advice is in counteracting natural misperceptions of the management task.

None of the advice is intended to be representative of any group of advisors. Rather they highlight what distinguishes the different advice. The advice is given in three versions.

1. Expert advice in the words of an "analyst", focusing on how the system works, and with a perfect quantitative advice for the first year's herd size R_1.
2. Expert advice in the words of an "activist", with no useful information about how the system works, and with a perfect quantitative advice for the first year's herd size R_1.
3. Fake advice in words that try to strengthen natural tendencies towards misperception, with a consistent and bad quantitative advice for the first year's herd size R_1.

The three, written advice read as follows.

Analyst
"Since the amount of lichen has decreased steadily under the previous owner, removal by reindeer grazing must have been greater than the natural growth of lichen in all previous years. Thus, in year zero in the historic period, the lichen growth rate must have been smaller than what is needed to feed 1150 animals. To increase the amount of lichen to a level that gives the maximum lichen growth, grazing must be reduced below the current growth rate for a while, then increased towards the growth rate again to stabilize the amount of lichen around the maximum sustainable level.
Concrete first advice: Reduce the herd size to zero in the first year, then gradually increase the herd size as the amount of lichen grows towards the level that yields the maximum lichen growth."

Activist
"The previous owner has followed an irresponsible policy of overgrazing. This is yet another example of the over-utilisation of renewable resources that have been observed so often around the world. The reason for the overgrazing is that the owner has been greedy and that the government lacks a firm policy to regulate the use of natural, renewable resources. The only sensible thing to do now is to reduce the herd size drastically, both to protect the natural environment and to ensure the sustainable operation of the reindeer business.
Concrete first advice: Reduce the herd size to zero in the first year, then gradually increase the herd size as the amount of lichen grows towards the level that yields the maximum lichen growth."

Fake
"The previous owner has built up the herd size carefully over the historic period. The data shows that the herd size has been increased to the current level without serious problems for the lichen and for the reindeer. Thus, drastic reductions in the herd size are not called for and would only bring the herd much below the sustainable level. In light of the considerable uncertainty about what adjustments are needed, a very careful trial-and-error approach should be applied when making adjustments in the herd size. Concrete first advice: In the first few years the herd size should be kept at 1800 animals, then one should observe the development before possible further adjustments to reach the maximum sustainable herd are considered."

Each subject participated only once such that we rely on between-subject comparisons of treatments. We have participants with three different backgrounds when it comes to understanding dynamic systems:

1. *Trainee*: Master students in system dynamics at the University of Bergen after one week of education where they learn about stocks and flows.
2. *Unskilled*: Master students in system dynamics at the University of Bergen on their first day of the study.
3. *Military*: Students at the Military Academy in Bergen with varied backgrounds.

4. Results

Figure 4 shows the optimal policy for the experimental task. Since initially, grazing exceeds lichen growth and the stock of lichen is below the point of maximum sustainable yield, the optimal policy is to reduce the number of reindeer to zero. This is consistent with a target escapement policy (Reed 1979). This enables the lichen to increase quickly to its maximum sustainable yield level, after which the number of reindeer can be increased to its maximum sustainable level.

Figure 4 also shows median results for the case with no expert advice for *Unskilled*. Participants typically decrease the number of reindeer only gradually from the starting point, inspired by the steadily declining amount of lichen (Moxnes 2004). As long as grazing exceeds growth, the gradual reduction in the number of reindeer is not sufficient to prevent the lichen from continuing to decrease. After 15 years, both reindeer and lichen are far below their optimal levels. From year 1 to 15, average lichen is significantly below the optimal lichen level (N=33, over years average $p \approx 0$). This and subsequent tests are Student's t-tests or Welch's t-tests.

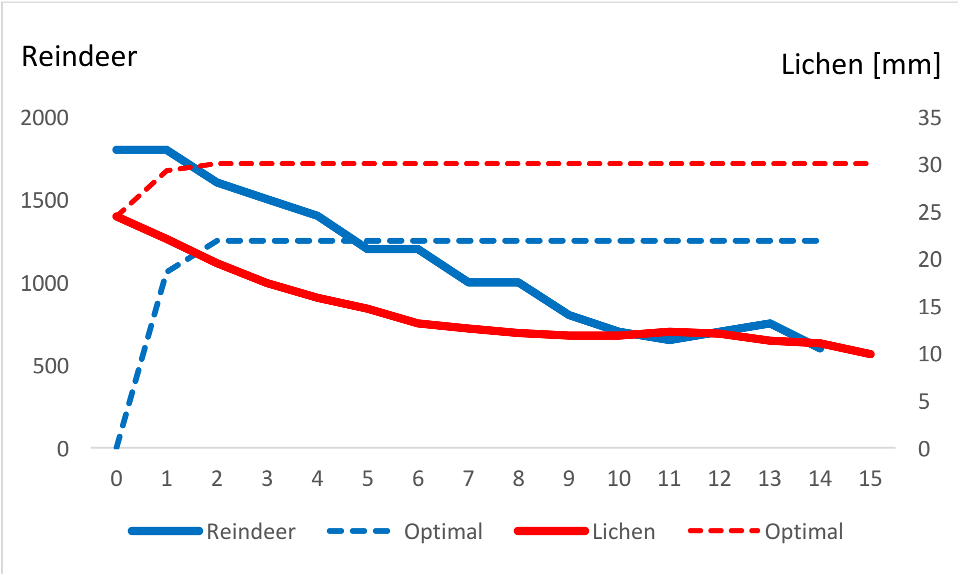


Figure 4: Reindeer (median result and optimal) and lichen (median result and optimal) for *Unskilled* with no expert advice.

Figure 5 shows that *Unskilled* on average perform not significantly different from optimal when they receive advice from either an analyst or an activist expert (pooled treatments, N=34, year 1 to 15 average p=0.57). When participants receive no expert advice, they perform on average poorly; lower than optimal and lower than when they receive expert advice (versus pooled expert advice, N=33 & 34, year 1 to 15 average $p \approx 0$).

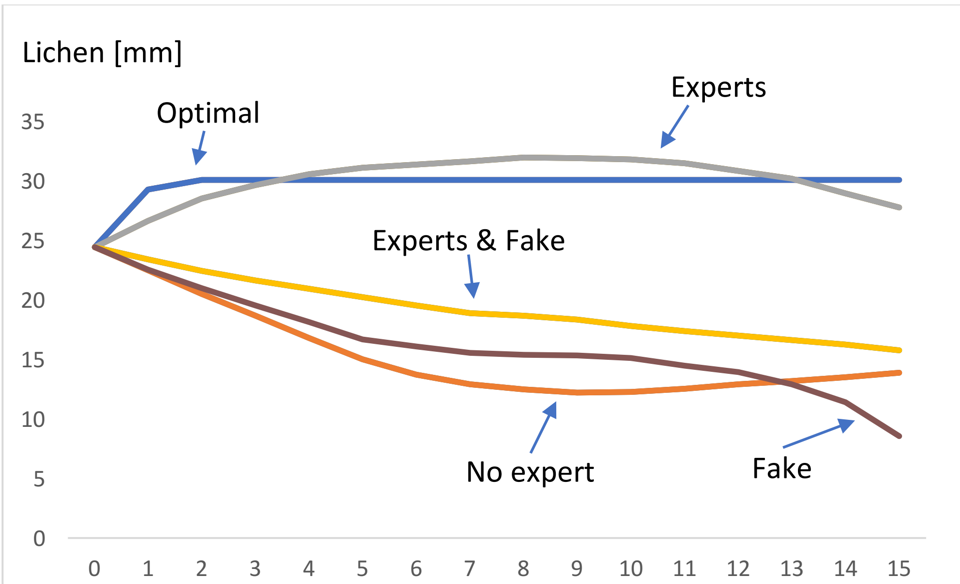


Figure 5: Optimal lichen management, average pooled experts (N=34, analyst and activist), average experts & fake experts (N=25, both analyst or activist experts), average fake expert (N=18), and average no expert (N=33). All data for *Unskilled*.

When the expert advice is combined with a fake advice, performance deteriorates towards the case with no expert advice. It becomes significantly lower than for the case with pooled expert advice (*N*=34 & 25, year 1 to 15 average *p* <0.002), and it is not statistically different from the case with no expert advice (*N*=34 & 33, year 1 to 15 average *p*>0.13). When participants receive only fake advice, the lichen is not significantly different from the case with no expert advice (*N*=18 & 33, year 1 to 15 average *p*>0.48).

Figure 6 shows the difference between lichen developments for activist and analyst advice; when both expert advice are combined with the fake advice. For *Military* students, lichen is marginally higher for activist than for analyst advice (*N*=21 & 21, year 1 to 15 average *p* =0.04). For *Unskilled*, activist is not significantly higher than analyst (*N*=18 & 16, year 1 to 15 average *p* =0.70). For *Trainee*, the sample tendency is in the opposite direction, but the difference is not significant (*N*=21 & 22, year 1 to 15 average *p*=0.48).

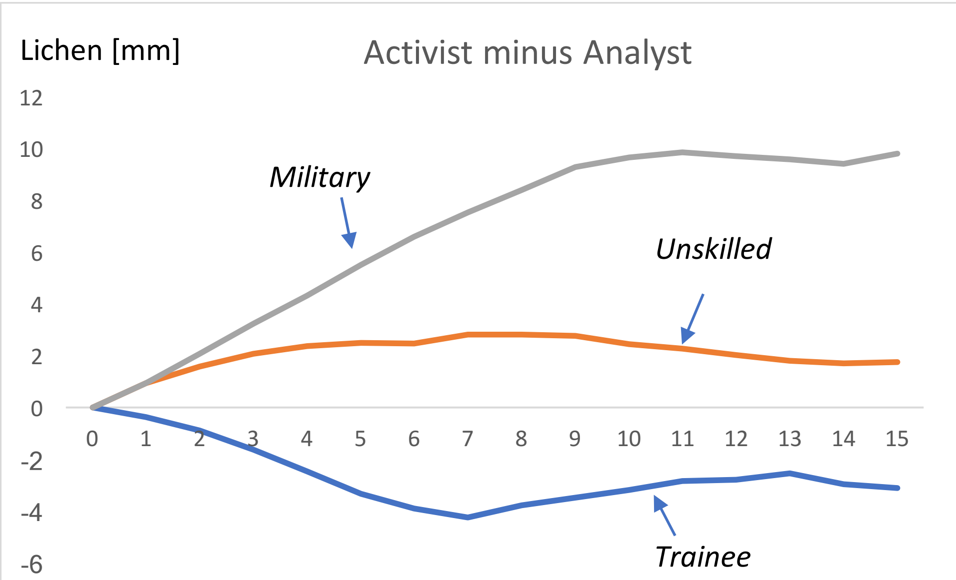


Figure 6: Differences between average lichen levels for advice given by activist and analyst, both advice are combined with fake advice.

Figure 7 shows lichen developments for the *analyst* and *fake* advice for the three groups of participants. *Trainee* performs significantly better than *Military* (*N*=22 & 21, year 1 to 15 average *p* =0.003), and only marginally better than *Unskilled* (*N*=22 & 13, year 1 to 15 average *p* =0.07). *Unskilled* is not significantly better than *Military* (*N*=13 & 21, year 1 to 15 average *p* >0.36).

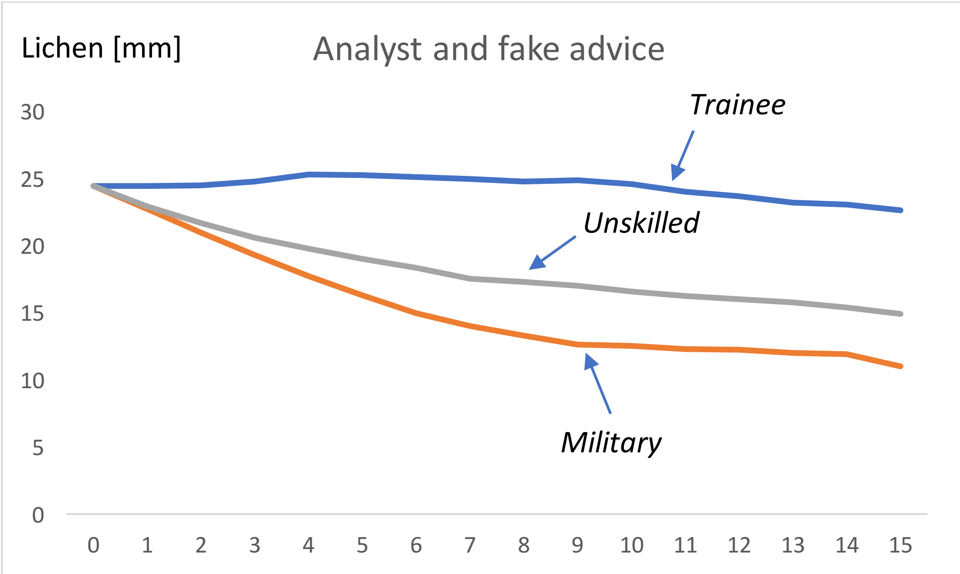


Figure 7: Lichen development with *analyst* and *fake* advice for three groups: *Trainee, Unskilled*, and *Military*.

Figure 8 shows lichen developments for the *activist* and *fake* advice for the three groups of participants. There are no significant differences.

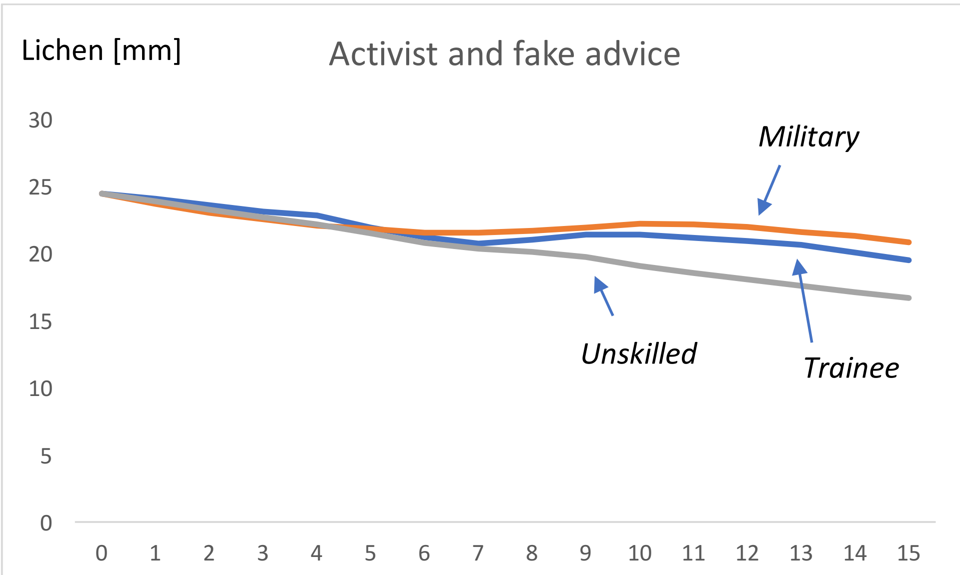


Figure 8: Lichen development with *activist* and *fake* advice for three groups: *Trainee, Unskilled*, and *Military*.

5. Discussions and conclusions

In most countries, majorities accept the scientific consensus about climate change (Maibach et al. 2014). Since the scientific consensus suggests that the major consequences of climate change will be bad, people have incentives to prevent climate change. Still, the relatively successful Paris agreement is still far from sufficient to prevent that acceptable levels of climate change will be exceeded.

The problem of managing the global climate is structurally similar to the management of reindeer and of fish resources. Historically, both reindeer and fish resources have been mismanaged. This has even happened in cases with private property rights and governmental regulation. Laboratory experiments with decision-makers, assuming private property rights, have replicated historical mismanagements of both resources (Moxnes 1998; Moxnes 2000). A likely explanation is that dynamic complexity forces decision-makers to rely on simple and inadequate decision strategies of the wait and see type. This complexity adds to other sources of uncertainty that create a felt need to collect more data before possibly costly policies are implemented (Sterman 2011). However, due to slowly changing stocks, waiting for proofs can be very costly. Moreover, the felt need for more information is typically exaggerated since experts already understand the dynamics of these resources very well. Since majorities now accept that there is anthropogenic climate change going on, efforts need to be directed towards combating inappropriate wait and see thinking.

However, wait and see strategies have many spokes persons, among activists, politicians, and even among scientists. In light of the well understood dynamics, we consider recommendations of wait and see strategies fake advice. For instance, according to Koonin : "…because the natural climate changes over decades, it will take many years to get the data needed to confidently isolate and quantify the effects of human influences." Koonin, being a theoretical physicist and former US Under Secretary of Energy for Science, expresses a widespread misunderstanding when he claims that the only way to learn is from ongoing experience. He neglects that climate science builds on established laws of nature and ignores prior information in the Bayesian sense. While acknowledging a potentially "terrible price in terms of human welfare" Houston (2013) writes: "I have favoured waiting a decade or two in order to test and improve the empirical reliability of our climate models, while also allowing the economies of the less-developed parts of the world to grow unhindered, improving their position to adapt to whatever heavy weather may come their way." In addition to relying on the argument about the need for more experience, he presupposes that economic growth in developing countries will not be harmed by climate change and that economic growth will outweigh the future negative effects of climate change.

It follows that there is much need for expert advice for the formation of proactive policies regarding reindeer, fishery, and climate management. The present experiment demonstrates that expert advice can improve management. When rerunning an earlier laboratory experiment of reindeer management with expert advice, average outcomes are no longer significantly different from optimal outcomes. Consistent with expectations, we find that fake advice that exploits natural tendencies to misperceive complex dynamic systems, has no significant effect on performance by itself. The result is not different from the treatment with no advice. However, when combining the expert advice with a fake advice, the effect of the expert advice is nearly nullified by the fake one.

The experimental results are obtained for students that have no prior knowledge and no personal interests in reindeer management. Hence, the subjects do not see the question about reindeer management as a threat to own income, own consumption, or own ideological convictions. The expected consequences of climate change, on the other hand, are likely to have negative impacts on most people's welfare. Logically, this should mean that for those that accept the scientific consensus, expert advice on climate policy should be more valuable and fake advice more harmful than the corresponding advice for reindeer management. Regarding acceptance of science, Kahan et al. (2012) find that "public divisions over climate change stem not from the public's incomprehension of science but from a distinctive conflict of interest: between the personal interest individuals have in forming beliefs ---." This could also be the case for those that accept the scientific consensus, and still have attitudes towards preserving the status quo. However, expert advice that makes explicit the danger posed by wait and see policies, could help shift focus towards policies that prevents future calamities.

Media has impact (Brulle et al. 2012) and it follows that media has an important role in explaining the danger of wait and see policies and in clarifying the need for proactive policies. Research shows that brief attempts to explain the structure of dynamic problems, as in Figure 1, has limited effects on policy choices (Moxnes and Saysel 2009, Moxnes, 2009 #4648). The present results show that it is only for the *Trainee* group that *Analyst* advice referring to structure has a larger effect than *Activist* advice with blaming.

However, rather than searching for culprits, media may have more impact if they present analogies to climate change in terms of narratives about mismanagement of for instance reindeer and fisheries. Such narratives are likely to answer some of the questions that wait and see strategies are supposed to answer, provided that people accept the analogies as structurally similar. The latter may require some formal training in distinguishing stocks and flows, recall the better results of the *Trainee* group. As a minimum, media, elites, and advocacy groups should make an effort to understand the dynamics of both climate policies and of policies in analogous systems. These groups have been found to be critical in influencing opinions (Brulle et al. 2012).

A first step is to report the current difference between global emissions and current removal of GHGs, and how long it will take to reduce emissions from production capacity below future removal rates. These facts make up a compelling logic to reject wait and see policies.

Understanding the danger of wait and see policies is more important than most people think. One often hears comments like "everybody knows that …", "people are well informed", and so on. However, even highly educated decision-makers in important positions simplify by relying on wait and see strategies. According to an earlier member of the US Federal Reserve, Blinder (1997): "I cannot tell you how many times, both at the Federal Reserve and at meetings with foreign central bankers, discussions of future policy were cut short with phrases like "let's see what happens" --. Unfortunately, this bit of received central banking wisdom is not at all wise."

Correct information is of great importance for the conduct of nations. The present experiment shows that valuable expert advice can be nullified by fake advice. Similar to pollution, fake advice can lead to great losses of welfare. With growing awareness of the costs, pollution has been regulated. The present experiment helps build awareness of the costs of fake advice, for instance in the form of overshoot and collapse developments for reindeer and fisheries, and future global climate. How to prevent fake advice while securing freedom of speech, should be a prioritized research and policy topic in the Internet age (Cook et al. 2017). As an indication that media policy matters, in Germany, media has given much less attention to arguments that are not supported by established science than in the US (Grundmann 2007). Consistent with this difference in media reporting, Germany decreased its CO_2-emissions by 28 percent from 1990 to 2015, while the US increased emissions by 3.5 percent[2]

[2] Source: OECD.stat (https://stats.oecd.org/Index.aspx?DataSetCode=AIR_GHG)

Appendix A: Common instructions and computer interface

You will play the role of the owner of a reindeer herd. Your task is to produce as much reindeer meat as possible each year. Note, however, you should make sure that your operation is sustainable. This means that you should aim for the highest possible herd size that can last for ever without destroying the lichen pasture. You should also try to reach this desired state as quickly as possible. Each year your only decision is to set the desired number of reindeer for the next year. You get only 15 years to reach the desired state, and no new trial. Do the best you can. The participant who gets the best results will receive a symbolic prize.

You are the sole owner of a given reindeer pasture. Nobody else has reindeer or other animals on your pasture. In summer, there is plenty of grass and herbs. The limiting resource is lichen to support the reindeer throughout the winter. Lichen is a small plant growing on the ground. Biologically it is a combination of fungus and algae. The lichen plant grows in the summer time, growth stops in the winter, and then the plant continues to grow "on top of itself" the next summer, and so on. When there is very little lichen present, there is only little growth. When there are lots of lichen (60 mm thick), the net growth of lichen tends towards zero, what grows up is just compensating for what rots at the bottom of the plant. In between these extremes, net lichen growth reaches a maximum. When the reindeer graze, they eat the top of the plant, and the plant continues to grow on top of what is left. One can measure the average height of the plants, also referred to as the thickness of lichen.

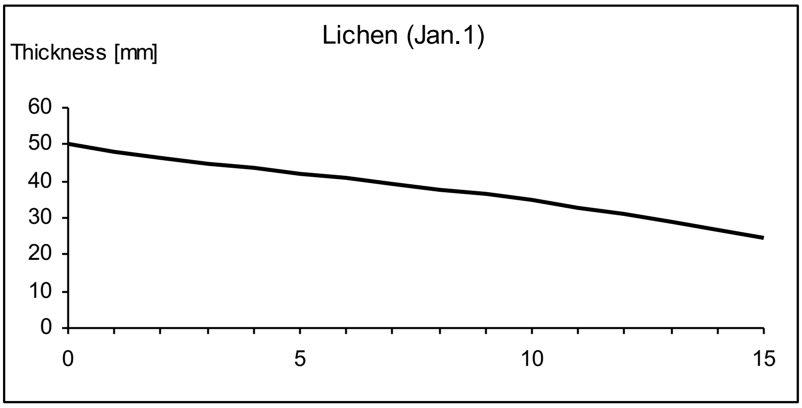
The size of the area is indicated by the following piece of information: In one year, the lichen eaten by 1000 animals is sufficient to reduce the average lichen thickness for the entire pasture by 4 mm. Lichen is vital for the survival of reindeer, if there is no lichen, all the animals will die. You can set the herd size freely, and you need not consider whether reindeer are sold or bought as a consequence of your choice.

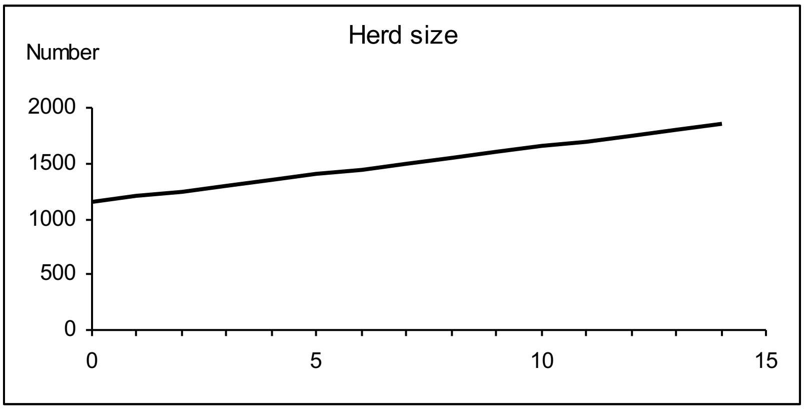
All measurements of the herd size and the lichen thickness are perfect and there are no random variations from year to year in the number of animals or the growth of lichen.

Before you take over the pasture, the previous owner has increased steadily the number of reindeer from 1150 to 1850. As a consequence, the lichen thickness [mm] has dropped from 50 to 24.4 mm. This development is shown in the diagrams and table below.

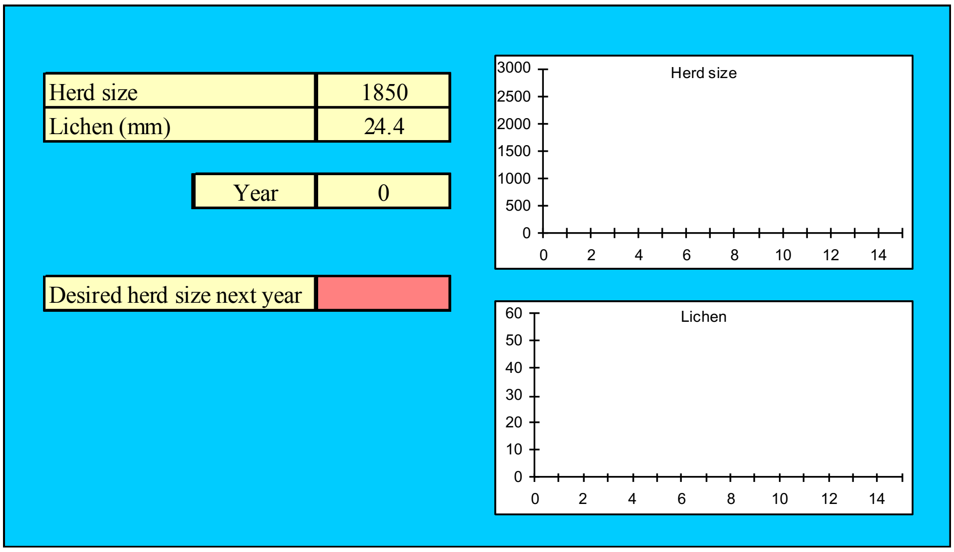
Good luck!

Historical development





Year	Lichen (Jan.1)	Herd size
0	50.0	1,150
1	48.2	1,200
2	46.5	1,250
3	45.0	1,300
4	43.6	1,350
5	42.1	1,400
6	40.7	1,450
7	39.3	1,500
8	37.8	1,550
9	36.3	1,600
10	34.7	1,650
11	32.9	1,700
12	31.1	1,750
13	29.1	1,800
14	26.9	1,850
15	24.4	



Computer screen for the experiment, programmed in the Excel macro language.

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