Are Commercial Fishers Risk Lovers?

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The result of changes in regulation or monitoring and enforcement of commercial fisheries are highly dependent on fishers' supply response decisions. One central determinant of fishers' reactions to such changes is their risk preferences. Empirical studies of fishers' preferences have found that most fishers are risk averse. In this paper, we conduct a stated choice experiment with Swedish commercial fishers to elicit fishers' risk preferences. The fishers face a series of binary choices of hypothetical fish trips where net income is assumed to follow a uniform distribution and varies in terms of mean and variance. We find that almost half or 49% of the fishers can be characterized as risk neutral or risk lovers, 17% are modestly risk averse while 34% state strong risk averse preferences. The fraction of a household's income generated from fishing is a significant variable in explaining risk attitudes, the higher fraction the more risk averse. Fishers' opinions about individual quotas (IQ) was also significant, the more positive to IQs, the more risk averse. The choice of gear type did not appear to influence risk attitudes and the same applied for our proxies of wealth. Neither boat size nor having a taxed wealth could explain differences in risk attitudes. This indicates that the short run decision of where and how to allocate a fishing trip of a few days does not depend on initial wealth level.

Keywords: Constant relative risk aversion, Prospect theory, Risk preferences, Swedish fisheries

1. INTRODUCTION

There is a growing interest in fishers' behavior under different regulatory regimes and their response to changes in regulation. A key aspect when trying to model fishers' behavioral motivations is the risk preferences amongst fishers. Despite the importance of risk preferences, we still have very little idea about determinants of risk attitudes and the heterogeneity or risk preferences among individuals in general (Beetsma and Schotman, 2001), and of fishers in particular.

Bockstael and Opaluch (1983) laid out the framework for studying choice under uncertainty among fishers. In their paper, they confirmed the somewhat strict hypothesis of all fishers in their sample having homogeneous risk preferences with a relative risk aversion equal to 1. In the study, New England fishers made annual decisions on target species and location choice, indicating substantial income levels at stake and hence risk aversion is the expected outcome within the expected utility framework. However, fishers often make decisions on a more short-term basis. Target species, gear choice, and location choice are decisions often made by fishers on a trip level, indicating a time span of 1 to 30 days. Mistiaen and Strand (2000) studied fishers' location choice on trip level, where a majority were using fishing grounds "easily accessed", but still found that more than 95% of the trips could be characterized as risk averse.[1] With repeated trips, most likely shorter than 15 days[2], and the maximum net revenue per individual below $1000[3], risk averse behavior is sub-optimal. For a repeated choice with modest stakes, risk neutrality is the optimal strategy. Within the expected-utility theory, risk neutrality is the expected-utility maximizing strategy (Arrow, 1971), and emphasized by Rabin (2000), which applies not only over modest stakes but also for quite sizable and economically important stakes. Eggert and Tveterås (2001) study fishers on trip level data, with a majority of trips being less than five days, and find that 30% of the trips can be characterized as risk neutral or risk loving.

[1] Fishermen are assumed to be normally distributed in risk preferences and the 5% risk lovers are at least in part an artefact of this assumption (see Revelt and Train, 1998)

[2] Trip length is unclear but the average vessel in their sample made 10 trips during a year. This implies an average trip length of 15 days, given an assumption of 150 days at sea per year and vessel.

[3] Vessel net revenue maximum is $2,750 and the largest vessel is 199 GRT with at least 3 crew members.

In this paper, we aim to elicit risk preferences among commercial fishers in Sweden using a choice experiment. Our study is, as far as we know, the first to estimate fishers' risk preferences using stated preference data. We collect information on the fisher's preferences by asking them to choose between pairs of different fishing trips described by mean net revenue and spread of the net revenue. The spread of the net revenue characterizes risk and the net revenue is assumed to follow a uniform distribution. Following the ideas of prospect theory (Kahneman and Tversky, 1979), we focus on current gains and losses rather than final wealth, and apply a constant relative risk aversion utility function. Based on the fishers' choice, we can calculate the degree of relative risk aversion in each alternative. By applying multiple binary choices, it is possible to obtain a lower and an upper bound of the size of relative risk aversion, i.e. this is basically a grid search. Our results indicate that a substantial part of the respondents, 36%, can be characterized as risk lovers, while 13% are risk neutral, and the remaining 51% are classified as risk averse. The fraction of a household's income generated from fishing is a significant variable in explaining risk attitudes, the higher fraction the more risk averse. Respondents who think that their overall quality of life is very high or high tend to be risk averse compared to the others. The Swedish fisheries are regulated open access with no element of individual quotas (IQ), which implies a potential threat of seasonal closure when the total allowable catch (TAC) for a species is caught. We asked fishers of their opinion about IQs and found that the more positive to IQs, the more risk averse. A small group of respondents who explicitly supports the social democratic party or the left party appear to be risk loving compared to the rest. The choice of gear type does not appear to influence risk attitudes. Grouping the respondents into trawl fishers, fixed gear fishers, and mixed fishers lead to insignificant variables. Notably, we find that our proxies for wealth are insignificant. Neither boat size nor having a taxed wealth could explain differences in risk attitudes. This may indicate that the short run decision of where and how to allocate a fishing trip of a few days does not depend on initial wealth level.

2. MEASURING FISHER'S RISK PREFERENCES

In real world fisheries, fishers have to make several decisions concerning choices and trade offs between potentially large amounts of discrete choices. These choices may include selecting target species, gear type, and location choice. Trade-offs to be made can concern expected mean revenue and revenue risk, but also aspects like comfort, safety, and trip length. Decisions can be made sequentially or simultaneously. In our framework, all these complex issues are condensed into a choice between two alternatives, and the two alternatives are completely characterized by the two parameters, mean and spread. Our point of departure is an expected-utility maximizing framework, but slightly revised using ideas from prospect theory (Kahneman and Tversky, 1979). In the empirical analysis we will use the constant relative risk aversion (CRRA) specification:

(1) $$U(y) = \frac{y^{1-\eta}}{1-\eta}, \eta \neq 1 \quad \text{and} \quad U(y) = \ln y, \eta = 1$$

where y is individual disposable income, and $-u''/u'$ is the absolute risk aversion, which can be multiplied with income to give the relative risk aversion, η ($-yu''/u'$). Johansson-Stenman, Carlsson and Daruvala (2002) develops a methodology for testing risk preferences in experiments, which we draw upon in this paper. We assume that net revenue is uniformly distributed in our experiment, which is easy to interpret and understand by the respondents. For a CRRA specification and a uniform density function, we have:

(2) $$E(u) = \int_{y_{min}}^{y_{max}} \frac{y^{1-\eta}}{1-\eta} \frac{1}{y_{max} - y_{min}} dy = \frac{1}{(1-\eta)(2-\eta)} \frac{y_{max}^{2-\eta} - y_{min}^{2-\eta}}{y_{max} - y_{min}}$$

In empirical applications of expected utility it is common to express y as a sum of W and x, where W is initial wealth and x is the net revenue, meaning that the sum of W and x is the final wealth. In the prospect theory developed by Kahneman and Tversky (1979), individuals attach utility, or more precisely "value", only to current gains and losses rather than to final wealth, indicating that W=0. Sandmo (1971) used a similar approach analyzing a competitive firm under price uncertainty and risk aversion.[4] In their experiments, Kahneman and Tversky (1982) find support for equation (1) as a description of individuals' evaluation of gains, i.e. y>0 which is the only case considered in our experiment. Through hypothetical choices between alternative fishing trips with different uniform net income distributions, the respondent implicitly states his degree of relative risk aversion. If a respondent is indifferent between two trips, we have that $E(u_A) = E(u_B)$ which implies:

$$\frac{y_{\max,A}^{2-\eta} - y_{\min,A}^{2-\eta}}{y_{\max,A} - y_{\min,A}} = \frac{y_{\max,B}^{2-\eta} - y_{\min,B}^{2-\eta}}{y_{\max,B} - y_{\min,B}} \quad (3)$$

This equation can then easily be solved with any standard numerical method. We use equation (3) to construct alternatives with different levels of η for the experiment. As fishers state which alternative they prefer, they provide either an upper or a lower limit of their level of η.

3. EXPERIMENT

3.1 The Survey

The choice experiment was part of a mail survey to commercial fishermen on attitudes to the current status of monitoring, enforcement and management of Swedish commercial fisheries. The survey also included questions on socio-economic characteristics of the respondents and their household in addition to question related to their fishing business.

In the introduction to the choice experiment, the respondents were informed about the framework of the experiment. They were asked to assume that the previous month of fishing had resulted in their average income and that their next fishing trip was a choice between two trips. The net income from these trips will vary in terms of mean and the range where the net income would lie, i.e. a lower and an upper bound are stated.[5] Further, the net income is assumed to follow a uniform distribution, i.e. the probability is identical for each amount in the given interval. Finally, it is stressed that despite their great skills as fishers they cannot influence the probability distribution. In the experiment, each respondent made six pair wise choices. The first alternative in each choice had the same mean and variance over the six choices, while the second alternative started with a significantly lower mean and variance, and then gradually increased over the six choices both in terms of mean and variance. The mean and variance levels are given in Table 1.

Table 1.
Fishing trips in the relative risk aversion experiment*

	Min. income	Mean income	Max. income	Relative risk premium if indifference between A and B	Relative risk aversion if indifference between A and B
Trip $A_{1\text{-}6}$	100	1000	1900		
Trip B_1	240	760	1280	240	η = 1.92
Trip B_2	310	865	1420	135	η = 1.18
Trip B_3	340	915	1490	85	η = 0.80
Trip B_4	370	960	1550	40	η = 0.41
Trip B_5	400	1000	1600	0	η = 0
Trip B_6	420	1030	1640	-30	η = -0.38

* All values in SEK. US$1 = SEK 9.20 (June, 2002)

These levels were chosen after testing with a focus group of commercial fishers and a pilot survey to commercial fishers. The levels given in table 1 correspond to a decreasing value of the variable η in equation (1). The six alternatives presented to the respondents are constructed by applying equation (3), where the first choice is assumed to be equal for a respondent with η=1.92. The second choice alters at

[4] Katz (1983) points out that Sandmo (1971) is wrong, due to the fact that profits can be negative and that the measures of risk aversion are properly defined upon wealth and not upon profits. In our setting profits can only be positive but the problem of risk preferences remain, indicating that we are not properly in the expected utility framework.
[5] The choice of mean income levels was based on information from data used in Eggert and Ulmestrand (1999) and Eggert and Tveterås (2001).

η=1.18 and the following values of η are, 0.80, 0.41, 0, and –0.38. The corresponding absolute risk aversion values are given in the last column of table 1. A respondent who consequently prefers fishing trip A to trip B in all six alternatives, seems to be a risk lover and to have a value of η which is smaller than -0.38, while choosing alternative B in all six choices indicate that η is greater than 1.92. If for example a respondent chooses A in the first three choice sets and then B for the remaining, we know that her degree of relative risk aversion is bounded between 0 and 0.41. Basically, the grid search approach will provide us information on a specific value on lower and upper bounds on the degree of relative risk aversion except in the case when a respondent chooses the same alternative in all choices, where one of the bounds goes to infinity (positive if choosing B and negative if choosing A). Thus, it is then possible to allocate respondents into one of seven groups.

3.2 Econometric specification

The responses to the choice experiment results in an outcome variable, which have an ordinal ranking. Thus, we use an ordered probit model to allow for this in the estimations (see e.g. Greene, 2001). We have that,

(4) $$y^* = \boldsymbol{\beta}'\mathbf{x} + \varepsilon$$

ε is assumed to be normally distributed across observations and y* is unobserved, but we do observe

$y=1 \quad \text{if } y^* \beta\ 0$
$y=2 \quad \text{if } 0 < y^* \beta\ \mu_1$
$y=3 \quad \text{if } \mu_1 < y^* \beta\ \mu_2$
$y=4 \quad \text{if } \mu_2 < y^* \beta\ \mu_3$
$y=5 \quad \text{if } \mu_3 < y^* \beta\ \mu_4$
$y=6 \quad \text{if } \mu_4 < y^* \beta\ \mu_5$
$y=7 \quad \text{if } \mu_5\ \beta\ y^*$

This gives us the following probabilities:

$\text{Prob}(y = 1) = \Phi(-\boldsymbol{\beta}'\mathbf{x})$
$\text{Prob}(y = 2) = \Phi(\mu_1 - \boldsymbol{\beta}'\mathbf{x}) - \Phi(-\boldsymbol{\beta}'\mathbf{x})$
$\text{Prob}(y = 3) = \Phi(\mu_2 - \boldsymbol{\beta}'\mathbf{x}) - \Phi(\mu_1 - \boldsymbol{\beta}'\mathbf{x})$
$\text{Prob}(y = 4) = \Phi(\mu_3 - \boldsymbol{\beta}'\mathbf{x}) - \Phi(\mu_2 - \boldsymbol{\beta}'\mathbf{x})$
$\text{Prob}(y = 5) = \Phi(\mu_4 - \boldsymbol{\beta}'\mathbf{x}) - \Phi(\mu_3 - \boldsymbol{\beta}'\mathbf{x})$
$\text{Prob}(y = 6) = \Phi(\mu_5 - \boldsymbol{\beta}'\mathbf{x}) - \Phi(\mu_4 - \boldsymbol{\beta}'\mathbf{x})$
$\text{Prob}(y = 7) = 1 - \Phi(\mu_5 - \boldsymbol{\beta}'\mathbf{x})$

A potential alternative would be to use interval regression and try to exploit the fact that that we actually know the cut off points. In this case, we have discrete log likelihood values for both the ordered probit and the interval models, which means that we can directly compare the log likelihood values of the two approaches. The larger log likelihood value, the better fit of the model.

4. RESULTS

The sample was drawn from the commercial fishing vessel register, which is administrated by the Swedish Board of Fisheries. The register contains a name of a contact person for each vessel, which is either the owner of the vessel or a representative for the company owning the vessel. In the latter case, it is most likely a senior fisher working on board who is also one of the owners of the vessel. In all, the register contained 1426 different names from which a random sample of 600 was drawn. The survey was conducted in February 2002, with a reminder sent out three weeks later. In the reminder, we asked the respondents, given that they didn't want to participate, to at least send in a blank questionnaire with a comment on why they didn't want to participate. In total 340 (57%) individuals returned the questionnaire, 41 of these were blank and almost another hundred had non-responses to various items. The final analyzed sample consisted of 202 respondents for which we present some descriptive statistics in Table 2.

Table 2.
Descriptive statistics for responding vessel holders, n = 202.

Variable	Mean (median)	Std.Dev.	Min.	Max.
Boat length (m)	14 (11)	8	5	50
Trip time (hours)	28 (12)	47	2	300
No of trips	124 (130)	66	0	300
Crew size (incl. Skip.)	2.0	1.6	1	12
Trawl	0.30	0.46	0	1
Trawl&fixed gear	0.11	0.31	0	1
Personal Income (SEK)	10000 (9000)	5000	1000	34000
Prop. Hh. Income (%)	61	26	0	100
Disp. Hh. Inc. (SEK)	18000	9000	2000	70000
Capital tax (yes=1)	0.24	0.43	0	1
University	0.13	0.34	0	1
Basic school	0.58	0.50	0	1
Left voters	0.10	0.30	0	1
Age	48	11	20	75
Very happy (yes=1)	0.18	0.39	0	1
Happy (yes=1)	0.45	0.50	0	1
Children (yes=1)	0.42	0.50	0	1
Individual quota attitude	2.4	0.98	1	4

We find that the median Swedish fisher has a vessel eleven meters long and he[6] carried out 130 12-hour fishing trips together with his colleague during 2001. The most common gears are fixed, e.g. gillnet and traps, which is the only type of gear for almost 60%. Trawl is the only type of gear for 30%, while 11% use both types. His personal income after all taxes are paid is SEK 9000, which is roughly 60% of the household's income and the disposable household income is SEK 18000.[7] We also note that the median (mean) annual net income, SEK 117000 (124000) corresponds very well to the interval of annual net income SEK 94000-134000 in the experiment. The latter figures come from multiplying the lowest/highest mean values in the experiment by the actual median and mean numbers of fishing trips. The educational level is distributed as 13% has at least completed a semester at the university, 58% has basic schooling (6-9 years depending on their age), while the rest has a medium long education of 10-12 years in school. Only 10% expressed explicit support for the social democrats or the left wing party, while the corresponding figure in the Swedish 1998 election was 45%.[8] The respondents were also asked to rank their overall quality of life on a scale divided into five degrees, with very high as the highest followed by high, medium, low, or very low. According to their answers, 63% are characterized as either very happy or happy. 42% of the respondents live in households with children at the age of 17 or less and 24% of the households paid a capital tax for year 2000, which implies possession of assets valued above SEK 1 million.[9] A majority of the responding fishers, 55%, are positive to introducing IQs in Swedish fisheries.

Clearly, the respondents form a heterogeneous group of fishers in terms of for instance vessels. The smallest vessels are in the range 5-9 meters with capacity of a few gross registered tons (GRT), while the largest vessels are 40-50 meters with capacity of many hundreds of GRT.

The results of the relative risk aversion experiment are presented in table 3. Of the 202 respondents, 36% consequently picked the A trips with higher variance indicating risk loving behavior. Switching to trip B in either choice 5 or choice 6, indicating risk neutrality, were selected by 13%, while 8%, 11%, and 6% switched from A to B in choice 2, 3, or 4, respectively indicating preferences for less risky alternatives. Finally, 26% consequently chose trip B, with the lower variance indicating risk aversion and a value of η larger than 1.92.

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[6] Sex was not recorded in the survey, but less than 1% in the register are females.

[7] In order to compare income between households, we employ the equivalence scale used by the National Tax Board (RSV) in Sweden. The scale assigns the first adult the value of 0.95, the following adults are set at 0.7 and each child at 0.61 units.

[8] We included all who stated either "don't know" or "don't want to answer", which were 40% of the respondents, in the group of others.

[9] Real estate property values in Swedish coastal areas have risen dramatically over the last ten years. Owning a house today with low mortgages in a coastal area, often implies paying capital tax.

Overall, we characterize 36% as risk-lovers, 13% as risk-neutral, and 51% as risk-averse.

Table 3.
Results of the relative risk aversion experiment

Parameter values	No.	Freq	Cum. Freq.
$1.92 < \eta$	52	0,26	0.26
$1.18 < \eta < 1.92$	17	0,08	0.34
$0.80 < \eta < 1.18$	22	0,11	0.45
$0.41 < \eta < 0.80$	13	0,06	0.51
$0< \eta < 0.41$	18	0,09	0.60
$-0.38 < \eta < 0$	8	0,04	0.64
$\eta < -0.38$	72	0,36	1

In the econometric analysis both interval regression and ordered probit models were tested, without any major differences in coefficient estimates. The log-likelihood value of the ordered probit, -326, was larger than for the interval regression, -338, and hence we report the results from the ordered probit model in table 4.

Table 4.
Ordered Probit model explaining risk attitudes

Ordered probit estimates   Number of obs = 202

LR chi2(12) = 29.5
Prob > chi2 = 0.006
Log likelihood = -326

	Coef	Std. Err.	Z	P>|z|
Boat length	.011	.015	0.760	0.45
Prop. Hh. Income	.011	.003	3.20***	0.00
Age	-.004	.009	-0.48	0.63
Capital tax	-.116	.195	-0.59	0.55
Eqhinc	.00002	.00002	0.84	0.40
University	.404	.272	1.49	0.14
Basic school	.215	.190	1.13	0.26
Left voters	-.522	.263	-1.98**	0.05
Trawl	.122	.245	0.50	0.62
Trawl&fix	-.078	.276	-0.28	0.78
Very happy	.447	.238	1.88*	0.06
Happy	.155	.187	0.83	0.41
Children	.023	.190	0.12	0.90
IQ attitude	-.155	.086	-1.79*	0.07

*** significant at the 1% level, ** significant at the 5% level, * significant at the 10% level

A positive and significant value of a coefficient indicates that risk aversion increases with that variable, i.e. the higher proportion of the household's income from fishing the more risk averse fisher. The coefficient of Individual quota attitude is negative and significant, indicating the more positive to IQs, the more risk averse. From our results it seems like a wealth effect on risk preferences is absent for Swedish fishers, neither the coefficient for boat size, nor the one for taxed wealth are significant in the regression. The small group of left voters compared to the rest state significant risk affinity in their preferences, while those who think their quality of life is very high are risk averse compared to the others. We also note that the gear categories do not significantly explain differences in risk preferences.

5. DISCUSSION AND CONCLUSIONS

To our knowledge this is the first attempt to elicit fisher's risk attitudes from stated preference data. Our impression is that the choice experiment with six pair wise choices between fishing trips with different risk characteristics work well. Most of the respondents understood the task and were able to make a choice, based on their attitudes to risk. Several of the respondents have added personal comments to emphasize their choices. One fisher who consequently chose the most risk avert alternatives remarked:

> *"Due to the drastic decline in cod catches my interest in taking chances has declined. Now it is a matter of keeping the business going"*

Two of the fishers who consequently chose the most risky alternatives, respectively made the remarks:

"I take a lot of chances" and *"Taking chances is part of the charm of fishing"*

However, some did not respond and one of them remarked:

"I don't answer this very academic question. You simply go for a strategy which yields the highest average profit"

To us, this sounds like a perfect risk neutral fisher. Using data from stated preferences implies a potential problem of not revealing true preferences. About 60% of the respondents either consequently chose trip A or trip B, while almost 40% started with the riskier trip A and then switched to trip B as the mean of B approached the mean of trip A. It may well be that some of the respondents chose the "extreme" alternatives as a means of reducing the cognitive burden in answering the questions. The use of a lexicographic strategy, consciously or not (Nisbett and De Camp Wilson, 1977), is helpful for the respondent in solving the exercise, even though his underlying true preferences may be more complex (Payne et al. 1993). For example, some respondents may have spent most effort on the first pair wise choice, and then repeatedly marked the same type of trip. In case of such behavior, the group of risk lovers, 26%, is over estimated. Future studies could probably avoid or test for such potential bias by spreading the η values over a larger interval and symmetrically around the risk neutral alternative (η=0).

Experiments in for example agricultural economics often include a risk free alternative, which for instance offers the possibility of determining the certainty equivalent (e.g. Pennings and Garcia, 2001). In fisheries risk free options hardly exists. This implies that fishing is always a choice between different risky alternatives, and any attempt to elicit risk preferences has to take that into account. Opaluch and Bockstael (1983) confirmed the hypothesis that the fishers in their sample were risk averse with η equal to one. That sample of fishers made an annual choice of location and species implying high stakes. In such cases or when stakes are even higher like the investment in a new fishing vessel, the expected-utility prediction of risk aversion seems likely to be confirmed. However, fishers often make decisions on a more short-term basis. Target species, gear choice, and location choice are recurrent decisions made by fishers on per trip basis, indicating a time span of 1 to 30 days for each trip.

The standard point of departure for economics is that rational agents have a long planning horizon, e.g. dynamic labor supply and lifetime wealth supposes that an individual evaluates over many years. This idea is frequently challenged by modern research in behavioral economics. Camerer et al. (1997) find that wage elasticity is negative for New York cabdrivers, i.e., they violate the prediction of dynamic labor supply models and work less hours during good days while working longer hours during bad days. Expected utility theory cannot explain the equity premium puzzle (Mehra and Prescott, 1988). In fact, the standard theory of expected utility is questioned and some influential scholars even claim that it "is plainly wrong and frequently misleading" (Rabin and Thaler, 2001). Two useful concepts from modern research on choice under uncertainty are loss aversion and mental accounting, which both explain modest-scale risk aversion. Loss aversion is part of the prospect theory (Kahneman and Tversky, 1979), where decision makers react to changes in wealth rather than levels. It is found that individuals are roughly twice as sensitive to losses than to gains, i.e. a coin-flip bet is only accepted if the odds are better than two-to-one. Mental accounting (Kahneman and Tversky, 1984) refers to the implicit methods individuals use to code and evaluate outcomes from for example investments or gambles. One example relating to mental accounting is that long-term investors seem to evaluate their portfolio more frequently than the actual time horizon of the investment. Benartzi and Thaler (1995) call the combination of short evaluation periods and loss aversion, myopic loss aversion, and hold that this phenomenon explains the equity premium puzzle. Loss aversion is most likely an important aspect also for fishers, which in our results is reflected by the clear effect of the proportion of the household's income. The larger share of the household's income, the less interest in taking risks. Short evaluation periods or narrow bracketing is a way of simplifying decisions by isolating them from the entire stream of decisions they are embedded in (Read and Loewenstein, 1996). The sub-optimal expected utility behavior of the fishers in the Mistiaen and Strand (2000) study makes sense if we take narrow bracketing into account. The fishers do not evaluate the annual outcome of several trips, but more likely evaluate each trip separately. Our study also seems to reflect myopic risk aversion, at least among the most risk averse. These fishers, 26% of the respondents, were willing to accept a 24% reduction in expected net revenue for a modest reduction in risk. Most likely these fishers will go on choosing the risk averse strategy all year around earning 24% less than they could do, due to that they overlook the possibilities of making a repeated choice and instead evaluate each fishing trip separately.[10]

Different risk attitudes will generate different responses to changes in regulation. Today, Swedish fisheries are regulated open access with no element of individual quotas (IQ), which implies a potential threat of seasonal closure when the TAC for a species is caught. When asking fishers of their opinion about IQs, we found that their opinions were a significant explanatory variable of risk attitudes. The more positive to IQs, the more risk averse. Our interpretation is that risk averse fishers are in favor of IQs compared to the current regime, at least partly due to the fact that with an IQ they can plan their fishing season without the uncertainty of potential closures.

Overall, expected-utility theory will offer no guidance in explaining fishers' behavior, at least not for all of their decisions concerning amounts relatively small compared to their lifetime wealth. Instead, we propose the tools offered from research in psychology and behavioral economics like loss aversion, mental accounting and narrow bracketing, when trying to understand fishers' risk preferences and supply response behavior. In our experiment even the worst outcome entailed a positive net income, in real life fishers now and then experience negative net income. Future research in this area should aim to find useful approaches of including loss alternatives. One approach could be to test if more lottery style experiments can function with fishers, e.g. a 80% chance of earning 1400 and 20% of loosing 600 compared to a 90% chance of earning 1100 and a 10% chance of loosing 400. However, not all fishers are loss averse. In our sample 36% appeared as risk lovers or in the words of one of them:

"Taking chances is part of the charm of fishing"

The risk loving alternative in our experiment had a modest negative mean difference, which could be explained by entertainment value. A first step to test for risk lovers is to increase the negative mean difference for the risky alternative to see if it still attracts fishers. Golec and Tamarkin (1998) study racetrack bettors within the expected-utility theory and find that bettors love skewness, but not variance. Whether fishers are skewness lovers remain as a task for future research.

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[10] Fishers stated their choice, knowing that the previous month was average, only for the next trip. However, recalling the effect of loss aversion, large variations in landings would rather make them even more risk averse. Only a fairly long period of continuous luck could potentially make them more risk neutral.

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APPENDIX: Translated questionnaire.

Next fishing trip

Assume that you are going for your next fishing trip. You are not sure about catch size, but you can choose between two types of trips. For the first one, net revenue value will vary a lot, but not so much for the other. Your net revenue will guaranteed be in between the stated highest/lowest net revenue. The chance is equal for all outcomes within the interval. Variations in net revenue may be due to choice of fishing ground and/or choice of fishing gear. We assume that your fishing net revenues were average last month.

In the example below there are two trips to choose between. They vary in spread and mean. How would you choose?

	Fishing trip A	**Fishing trip B**
Lowest/highest net revenue (mean value):	100-1900 SEK (1000 SEK)	400-1550 SEK (975 SEK)
Your choice:		

Fishing trip B implies that you are guaranteed a minimum of SEK 400, if you prefer that to possibly only get SEK 100 you choose B. On the other hand fishing trip A means a chance of making a net revenue of SEK 1900, if you prefer that to a potential max of 1550 you choose A. On average trip A will yield SEK 1000, while trip B will yield 975 on average. Your choice only concerns the next trip.

We ask you to state your choice between the different trips. There are no correct answers, we are interested in your choice. We do acknowledge that these choices are not perfectly equal to real life fishery choices, but we are very interested in your judgements. We assume that you are a skilled fisher, but you cannot influence the probability outcome. The net revenue from the trip is somewhere in the stated interval and each value within the interval is equally probable to occur.

	Fishing trip A	**Fishing trip B**
Lowest/highest net revenue (mean value):	100-1900 SEK (1000 SEK)	240-1280 SEK (760 SEK)
Your choice:		

	Fishing trip A	**Fishing trip B**
Lowest/highest net revenue (mean value):	100-1900 SEK (1000 SEK)	310-1420 SEK (865 SEK)
Your choice:		

	Fishing trip A	**Fishing trip B**
Lowest/highest net revenue (mean value):	100-1900 SEK (1000 SEK)	340-1490 SEK (915 SEK)

Your choice:		

	Fishing trip A	**Fishing trip B**
Lowest/highest net revenue (mean value):	100-1900 SEK (1000 SEK)	370-1550 SEK (960 SEK)
Your choice:		

	Fishing trip A	**Fishing trip B**
Lowest/highest net revenue (mean value):	100-1900 SEK (1000 SEK)	400-1600 SEK (1000 SEK)
Your choice:		

	Fishing trip A	**Fishing trip B**
Lowest/highest net revenue (mean value):	100-1900 SEK (1000 SEK)	420-1640 SEK (1030 SEK)
Your choice:		