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Impact of mosquito nets on fisheries

Rapid research for GiveWell

Global Health and Development Department

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Global Health and Development at Rethink Priorities

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Context

In April 2024, GiveWell commissioned Rethink Priorities to conduct research on mosquito nets. The aim was to briefly evaluate whether some nets that are distributed but not used could be causing harm if they are being used for fishing. This rapid research focused on whether greater demand for existing fish stocks could lead to depletion and disrupt long-term sustainability and food security, which we refer to as "overfishing".

The table below shows an overview of the potential harms and benefits of overfishing due to mosquito nets. These are discussed further in the report.

Table 1: Overview of potential harms and benefits of overfishing, by mechanism

Mechanism leading to overfishing	Potential harm	Potential benefit
Increased productivity/ intensity of fishing, due to smaller mesh size	Catch smaller/ juvenile fish, which could have long-term impacts on supply and on food chain	Eating small fish whole may increase consumption of micronutrients
Increased number of people fishing, because nets are often received free	Increasing demand could have long-term impacts on supply	New entrants may increase protein intake and/or income New fishing may be done by women, increasing autonomy

Note. Compiled by Rethink Priorities, primarily based on GiveWell's conversation notes with Rebecca Short.

We spent 16 hours on research related to this question. We provided GiveWell with this write-up, in relation to the four questions that they specified.

Animal welfare considerations are outside the scope of this rapid research. We also did not investigate the potential impact of insecticides when nets are used for fishing, as this was out of scope.

Executive summary

Overall, lack of evidence means that arguments supporting both harms and benefits of mosquito net fishing (MNF) rely on "first principles", and are hard to quantify and weigh against each other.

There's no better evidence on the prevalence of MNF than GiveWell has already identified, though there are some more recently published studies of prevalence in specific locations. Short et al. (2018) does not allow for a robust estimate of how widespread the phenomenon is.

- A 20-minute attempt to estimate prevalence based on the total number of people fishing in Africa and the upper bound of location-specific prevalence (66%) yielded an estimate that MNF is practiced by roughly 0.6% of all people (and using 1.2% of all nets). However, our confidence interval for these estimates remains large (e.g. up to 5% of people).

There's no quantitative evidence of nets leading to depletion. We spent approximately a third of the research time looking at the question from first principles, and confirmed that a) mosquito nets have smaller mesh sizes, and b) the cost of a fishing net is likely prohibitive to many poor households. As such, it's plausible that fishing with nets could lead to overfishing.

- However, the argument seems to turn on how much damage you think catching juvenile fish does. This is our largest source of uncertainty, and we think it would most efficiently be answered by consulting an expert. We would suggest Alexander Tilley or Jeppe Kolding to discuss the view that it may not be that harmful, as well as one of the co-authors of Zhou et al. (2019).
- It seems important to ask experts both of the following:
    - What's the likelihood of depletion, or likely rate of depletion due to MNF?
    - How many years would be needed for fish stocks to recover if a given level of depletion occurs? Or in other words, how many years of food insecurity should be expected?

Depleted fish stocks do seem like they negatively (and both directly and indirectly) impact food security in Africa - particularly micronutrient deficiencies - but the magnitude is rarely quantified. Extrapolating from two sources suggest that severe (or near total) declines in fish stocks could increase the proportion of the population facing food insecurity in the range of 10-15 percentage points, but again this is highly uncertain.

- Increasing aquaculture in Africa may mitigate the effects beyond the poorest households.

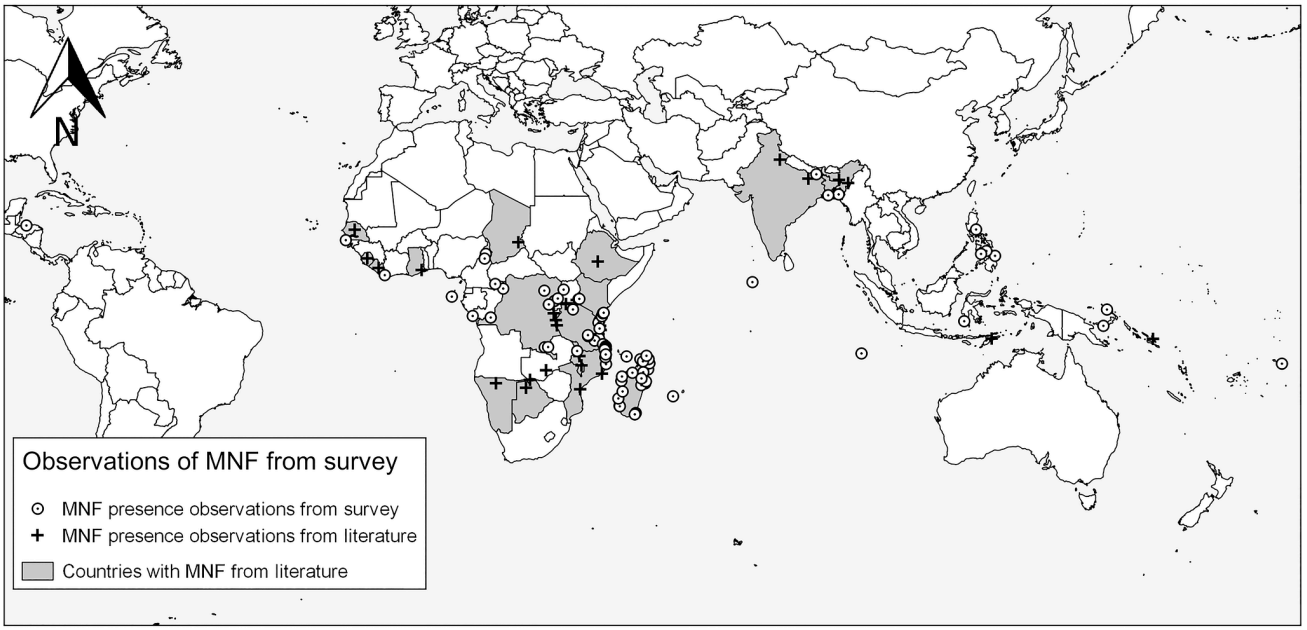
Regarding benefits, in the short run, it feels plausible that better access to (small) fish could be positive for maternal, neonatal and child health outcomes. However, academics do not seem to explicitly state this as a potential benefit of MNF. We spent significantly less time investigating the potential benefits of MNF, versus the potential harms, and as such we remain highly uncertain.

Given the scarcity of evidence on this topic, it might be worthwhile for GiveWell to conduct their own data collection. While we do not have enough context to estimate the value of information, it does seem that there are some significant gaps that could be addressed at relatively low cost with a light touch study. For example, GiveWell could consider adding a question about MNF to ongoing M&E activities to better understand prevalence.

Is fishing with mosquito nets widespread in sub-Saharan Africa where mosquito net campaigns occur (i.e., do lots of people live near fish-able bodies of water, and many of them use ITNs to fish)?

GiveWell has already identified Short et al. (2018) as the most comprehensive survey of MNF globally. The underlying data for the review comes from an online survey conducted in 2015, and based on the methodology we do not expect the results to be either complete or representative.[1] 113 respondents to the survey recorded 94 observations of MNF globally (and 36 observations of absence). While we have not looked at the questionnaire, our impression is that respondents simply needed to have observed MNF at any time, not to have engaged in the behavior themselves recently. Survey responses do not capture observations of MNF in all countries where this behavior had previously been reported. The figure below shows the geographic distribution, but the data from this article does not give any sense of scale.

Figure 1: Observations of mosquito net fishing



Note. From Short et al. (2018, Figure 1).

We found very limited additional research into the prevalence of MNF since 2018.

- We checked the 67 papers that have since cited Short et al. (2018) in Google Scholar, and found only one additional paper that contains new information about how often people use nets to fish. Samoilys et al. (2019) observed the use of different fishing gear in six rural villages dependent on small-scale fishing across 80 km of coastline in

[1] From the article: "An online survey was made available in English and French between 4/6/15 and 14/8/15 using the Qualtrics Survey Software. Information regarding MNF was requested from anyone living or working within any area of malarial risk, either coastally or close to bodies of water used for fishing at any scale, with a focus on obtaining responses from relevant stakeholders in the fisheries management, public health, conservation and development sectors… We promoted this survey to relevant respondents through the authors' own networks, relevant mailing lists, newsletters, conference delegate lists and direct targeting of relevant individuals and subsequent networks through internet searches. Social media outlets Facebook and Twitter were utilised extensively with all authors' affiliated organisations participating and expanding the reach. Every effort was made to ensure geographical representation and to limit potential bias from factors such as prevalence of NGO activity in an area."

Mozambique.[2] Based on interviews with 2,454 fishers, the study found that on average mosquito nets were used by 27% of fishers, but this varied from 10% to 42% across villages.
- A report on destructive fishing activities in the South coast of Kenya finds that 3% of those surveyed use small size mesh nets, like mosquito nets (Munyi, 2024). However, the underlying data is from interviews conducted in 2007 - 2008, and the data collection section does not indicate the sample size.
- Hondo et al. (2023) included data from surveys with 280 individuals conducted in lake-side villages in Benin in 2020. The authors find that two thirds of those surveyed use mosquito nets for fishing.

We spent approximately half an hour trying to find information about what proportion of the population in sub-Saharan Africa (SSA) lives near fishable waters. The closest quantification that we could find were estimates of how many people are involved with fishing.
- Based on "population censuses, labour force surveys and household income and expenditure surveys conducted by governments' national statistics agencies", Virdin et al. (2023, Table 1) estimate that there are 4.66 million subsistence fishermen in Africa, and four million people employed commercially to fish (with another approximately five million for pre-harvest, processing and trading tasks).[3]
- de Graaf & Garibaldi (2014) estimate that roughly six million people in Africa are employed as fishers in the sector Africa. However, this estimate likely does not capture subsistence fishing, and is based on a sample of surveys from 23 African countries that is more representative of Western and Central Africa than other regions (p. 10).
- de Bruyn et al. (2021) seemed promising, as a scoping review of fish acquisition and consumption in the Great Lakes region, but does not include any quantification of access to fish.

We then spent 20 minutes working towards a very rough estimate of MNF prevalence.
- As a starting point, we chose to use the highest estimate from Virdin et al. (2023), with ~10.5 million people involved in subsistence and commercial fishing in Africa in 2016.
    - This source indicates a total population of 1.2 billion people in Africa at the time, which would suggest 0.875% of the population is fishing.
    - This percentage likely varies significantly across countries, such that it is much higher in some, e.g. Senegal, Madagascar. However, it's not immediately clear to us whether GiveWell should expect that the proportion of people fishing in the set of countries in which it funds net campaigns to be higher than this average.
    - It's also unclear whether we should expect that official estimates of the number of people involved in fishing are too low: our prior here is probably yes.
- Based on the sources above from Benin and Mozambique, between 10% - 66% of those fishing were using mosquito nets.
- Combining this information, if we take the upper bound figure for MNF in fishing communities, then perhaps roughly 1% of the population fishing * 66% of those fishing using mosquito nets = **0.66% of the total population is using nets to fish.**
    - **Our 70% confidence interval on this is very large, from 0.5% - 5%** of the total population using nets to fish.

[2] To quantify "dependence on small-scale fishing", in these locations 48% - 70% of economically active villagers are engaged with fishing.
[3] The supplementary material (pp. 9 - 10) suggests that for Africa the estimate is almost entirely based on household income and expenditure surveys. All data is from 2008 - 2018, adjusted to 2016. On skimming, we did not see a breakdown of surveys used by country and year, so we are unsure about the representativeness of the underlying data.

- Thinking in terms of nets, if we assumed that each person fishing used one net for the activity, then this represents 0.66% fishermen/person * 1.8 people/net * 1 net/fisherman = 1.2% of all nets.
    - Our confidence interval on this is even larger, given that it's not clear from quickly skimming the literature how many nets are being used by each fisherman. Discussion of multiple nets being sewn together for some types of fishing, and of nets being sold to fishermen, suggests that this may be higher than one.

Does fishing with nets cause a significant depletion in fisheries?

When commissioned to do this research, GiveWell shared that they were already aware that depletion of fisheries is occurring in SSA. The key question is to what extent mosquito nets are contributing to this depletion. As outlined in Table 1, there are two ways that mosquito nets might cause depletion: by catching more juvenile fish than traditional nets, or by increasing overall demand as new people start fishing.

We searched briefly for a resource that broke down the contribution of different reasons for depletion of fisheries, but did not find any quantitative results - with or without MNF as a cause.

We then searched Google Scholar for the term "mosquito net" along with "overfishing" or "fish depletion". One resource was interesting, but still inconclusive about the relationship. Bush et al. (2016) investigates the use of mosquito nets in a marine reserve in Kenya, bordered by villages with a population of ~9,000 people.[4] The authors ask respondents about their perception of changes in fish abundance and size over time, and plot this against recollections of whether respondents were using mosquito nets at the time. Increasing concerns about a rapid decrease in fish populations coincide with recollections of net use (1970s - 1980s).

- Our concerns with this data are that it is qualitative, likely very affected by recall/recency bias, and correlational. However, from the description of the site, the location does seem fairly isolated and perhaps could be a case study in which other potential sources of depletion are less likely to occur (e.g. foreign illegal fishing).

In the absence of any existing quantitative research on this topic, we thought about other ways to try and address the question.

1. Idea: Consider a selection of sites where we know MNF occurs, and try to determine whether there is evidence of depletion.
    a. Decision: Not possible. While Short et al. (2018) and other resources mentioned above identify some locations, the reports do not include any quantification of fish stocks over time.
2. Idea: Consider a selection of sites where we know depletion is significant, and try to determine whether MNF is occurring.
    a. Decision: Not possible, because there is generally very little information about where MNF is occurring (as discussed above).
3. Idea: Pursue a first principles approach to try and determine whether the mechanisms for overfishing seem plausible.
    a. Decision: We ultimately pursued this, for approximately three hours.

[4] A few notes on the methodology: the authors conducted interviews with 51 randomly selected homesteads in 2013, and found that 24 of 51 households used mosquito nets for fishing. The vast majority of nets were received through mass distributions and in 92% of cases nets were in use for fishing after being "no longer deemed fit for beds".

Smaller mesh sizes and juvenile fish

Is the mesh size of a mosquito net actually smaller than what would otherwise be used by those fishing?

We checked three net specifications,[5] which indicate that the mesh size for a net is commonly at least 24 holes/cm^2. For simplicity, if we imagine 25 holes in a 5x5 grid within a 1 cm^2 area, this would suggest each hole has a diameter of 2mm.

Diekert et al. (2022) investigates whether subsidies could be used to encourage the use of legal nets for dagaa fishing on Lake Victoria, and defines a legal net as having a mesh size of at least 8mm (pp. 6-7). It's not entirely clear what measurement this represents, but if it's diameter then the mesh is significantly larger than that of a mosquito net.

- However, the authors report that many of those fishing use locally-made nets with a smaller mesh size. They cite a survey from the Lake Victoria Fisheries Organization (LVFO) in 2017 that finds that > 90% of all nets have a mesh size below the 8mm regulation.
- Looking at the 2020 survey (LVFO, 2021, p. 61), the most prominent mesh size used was between 5mm and 8mm, and nets with a mesh size <=5mm are uncommon.[6]

Our **tentative conclusion is therefore that mosquito nets do have smaller mesh size than the nets otherwise used for fishing**, with a conservative estimate being a difference of 2mm diameter versus ~5-8mm diameter. However, we have several uncertainties about how well this result generalizes.

- Diekert et al. (2022) focuses on dagaa fishing, which uses the "seine netting method".[7] We don't know if this is the method for which mosquito nets are often used.
- The mesh size difference may be much larger for other kinds of fishing. For example, gillnets are required to have holes > 6 inches (LVFO, 2020, pp. 7-8).
- The mesh size measurements from the LVFO survey are from a well-established fishing location. It's unclear whether the fishing nets already in use in other settings, where we may expect it's more likely the nets are locally made, would have bigger or smaller holes.

Broadly, however, **we would expect mosquito nets to catch smaller fish than fishing nets.** We did not specifically look for evidence to support this, and the one source that we found opportunistically that investigated this question was low quality.[8]

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[5] The three nets were the PermaNet 2.0 and Interceptor G2 (both 24 holes/cm^2), and the PermaNet Dual (26.5 holes cm^2). We chose these three nets because they are widely used and likely to remain so.

[6] The report suggests that mesh size between 5mm to 8mm constitutes 99.4% of all small seines, but this appears to be an error because the report then cites mesh size <5mm as 14.7% of the total and 8-10mm as 6.7% of the total. However the table on p. 25 does show the majority of nets are below 8mm.

[7] Description from p. 6: "To catch dagaa, fishermen use the seine netting method. For sein netting, the typical fishing crew vertically connects three or four net panels to form a larger net used (ca. 100 meter long and 15 meter deep) to catch schools of dagaa that are lured to the surface by kerosene lamps at night."

[8] Nordgren (2014) is a Master's thesis investigating fishing using beach seines in Madagascar, where many beach seines include mosquito-net paneling. The methodology from the paper is not entirely clear, but we think the author surveyed 27 beach seine fishermen in 2013 and then bought and analyzed the composition of their catch, including the size of the fish. Some nets had mosquito net panels, so this could, in theory, provide some data to test the hypothesis that MNF leads to more juvenile fish being caught. Regression analysis finds no significant relationship between the use of mosquito nets and fish size (and other measures of catch), but we are not confident about the quality of the statistical methods used. For example, the author finds no relationship between having mosquito net "cod-ends" and the size of the catch, but describes that all 17 different kinds of beach-seines have this kind of cod-end (p. 56). Without

Does catching smaller/juvenile fish necessarily lead to depletion/ overfishing?

The answer to this question appears to depend on whether you subscribe to the idea of "balanced harvesting" for fisheries management. Our impression is that this concept is similar to random sampling: if a mosquito net has a very small mesh size, it should capture a representative sample of the fish in the environment, therefore avoiding negative effects of changing structures (e.g. removal of fish with particular ecological functions, like predators).

This feels like a question that would **most productively be answered by speaking with an expert**. Tilley et al. (2019) disputes the assumption that catching juveniles will have a substantial impact on sustainability, arguing that fish are adapted to high juvenile mortality. It may be worth speaking to one of the four co-authors.[9]

- We also briefly skimmed Zhou et al. (2019), which considers the "concept, policies, evidence, and management implications", and speaking to a co-author may result in a more balanced interview.

Zhou et al. (2019) mentions one case study that would be particularly interesting to explore. Lake Kariba, is described as "shared almost equally between Zambia in the north and Zimbabwe in the south". Between the 1950s and 1990s, Zimbabwe enforced regulations on fishing gear - including regarding mesh size - while Zambia did not, such that the lake became a natural experiment. The ultimate conclusion of an FAO-published study of the lake was that "there are no indications of biological overexploitation in the Zambian inshore fishery in terms of reduced total yields or changed fish communities" (Kolding et al., 2003). However, on quickly skimming this case study we couldn't tell whether the mesh sizes in use on the Zambian side ever decreased to be as small as those for mosquito nets, and whether this conclusion would still hold if they had.

Overall, **we do not know enough about fisheries management to come to a view on this question. We think this is a crux of the overall argument about potential harms from MNF, and worth pursuing further through expert discussion.**

Is the counterfactual to MNF not fishing at all? Or in other words, do households that are not currently fishing start fishing because they receive mosquito nets?

Our conjecture is that the answer to this question depends on the cost of a fishing net: if a fishing net is cheap and households are not already fishing, then we would not expect the receipt of a mosquito net to change their behavior.

We spent very little time searching for fishing net prices, as we expect this varies a lot across locations and don't think this is likely to be documented well online.

- A New Scientist article from 2019 suggests a traditional net "can cost anywhere from 70,000 to 150,000 Kenyan shillings", which is $550 to $1,180 (if converted today). However, there's no information about the size or type of net.
- Diekert et al. (2022) also includes information about prices. They report that a single fishing net panel costs ~$26 if locally made and generally lasts half a year; if imported from Asia, the panel costs ~$82 and lasts for two to three years (pp. 7-8). It's worth noting

any variation on this variable, we would not expect the analysis to try to estimate the effect of using mosquito net cod-ends.

[9] Note that one of the co-authors is Rebecca Short, with whom GiveWell has already spoken.

that, based on Figure A-2 (p. 38) and the description of seine fishing (p. 6), these panels are much larger than mosquito nets.
- Munyi (2024, p. 16) reports on the price of non-destructive fishing net on the South coast of Kenya in 2007 - 2008. He reports an average price of ~18,000 Kenyan shillings, which is ~$138.[10]

It's hard to come to a conclusion here, but **it does seem like nets are expensive enough that this presents a barrier for households - particularly poor households - to start fishing**. Receipt of a mosquito net could overcome that barrier and increase the total number of households fishing. However, we did not find any specific evidence that this is occurring.
- One survey of fishermen on Lake Tanganyika in the DRC (De Keyzer et al., 2019, p. 12) found that although they reported "declining catch-rates, fishermen in our survey did not report that there was overfishing or overpopulation", but we do not consider this convincing evidence to the contrary.

As an alternative, Berthe et al. (2019) suggests that in Malawi poor households may sell their nets to fishermen for the equivalent of $0.40 - $1.40. This would slow the rate of new entrants to fishing, but still increase the use of small mesh nets.

Does fishery depletion significantly impact overall food security?

We can think of a number of ways that fishery depletion could impact food security:
1. Directly, due to inability to continue subsistence fishing
2. Indirectly, due to reduced ability to purchase and consume fish (due to lower supply and/or higher costs)
3. Indirectly, due to losing employment in the fishing industry - whether engaged in commercial fishing, or processing catch, or trading fish, etc.

In ~2 hours of searching, we found that the relationship between fish and food security is often discussed, but rarely quantified.

The most direct attempt at quantifying the effect of fish depletion on health was Golden et al. (2016), although this resource has several drawbacks: its methodology is not entirely transparent (even in the supplementary information), it seems partially motivated to produce a high estimate,[11] and it is not specific to SSA.
- The authors calculate that 19% of the population are "vulnerable to deficiencies because fish make up more than 20% of their intake of these foods by weight". They further estimate that if global fish stocks continue to decline at a rate of 1% per year "in the coming decades" then 11% of the global population "are poised to become deficient" in zinc, iron or vitamin A.
    - We find this description exceedingly vague, and we couldn't immediately tell what total reduction in fish stocks is linked to deficiency in 11% of the population.
- Many areas in SSA are called out as reliant upon fish and vulnerable to micronutrient malnutrition. In particular, the following countries with past or present GiveWell-funded net campaigns are highlighted: Ghana, Guinea, Nigeria.

[10] The conversion to US dollars is very imprecise, as it uses today's exchange rate between Kenyan shillings and USD, despite the fact that the data comes from 2007. However, we are more interested in the order of magnitude of the cost, more than the exact cost, so we chose not to calculate this more precisely.
[11] The authors explicitly state that they make a decision to double a threshold used in their analysis because they "feel [the lower option] is an irresponsibly high proportion required for raising an alarm".

    - Some countries could not be evaluated due to lack of data, including Chad and the Democratic Republic of Congo.

As an alternative, Simmance et al. (2022) investigates the benefits of proximity to a small-scale fishery. This is the inverse of GiveWell's question, so it may be possible to use this to guide an estimate of what would happen to communities if small-scale fishing was to cease due to depletion. Based on a representative sample of 18,000 household survey responses for Tanzania, Uganda and Malawi,[12] the authors measure proximity to and involvement with small-scale fishing, as well as food security (as measured by a Food Consumption Score).

- Using a multivariable regression that controls for other factors such as employment, education levels, and wealth, the authors estimate that being proximate to a water body (~2.7km on average) lowers the probability of being food insecure by 12.6 percentage points.
- Additionally, they find that in the aggregate sample, households directly engaged in small-scale fishing are more food secure than agricultural households (by ten percentage points) and neither fishing nor agricultural households (by five percentage points). However, this does not hold true in Uganda when the data for this country is considered alone.

Extrapolating very roughly from these sources might suggest that something like 10-15% of households in Africa might become food insecure if fish stocks were (severely) depleted. However, the evidence doesn't immediately lend itself to forming a view of smaller changes in fish stocks, e.g. an x% drop in fish stocks leads to a y% increase in food insecurity.

- This seems quite high, but evidence suggests that many in SSA rely on fish as an important source of protein: Muringai et al. (2022) suggests that "fish accounts for more than 30% of total animal protein in Africa".
    - However the direct effects of depletion on consumption could be partially offset by the rapid development of aquaculture in Africa: Muringai et al. (2022) suggests that "one fish in every two consumed is from aquaculture".
    - Chan et al. (2021) suggest that in Africa, between 1999 - 2019 the proportion of production from aquaculture has grown by 11% per year. Additionally, Chan et al. state that 95% of Africa's aquaculture is in eight countries, many of which have received GiveWell funded nets in the past.[13]
    - We would still expect that the poorest households would likely be unable to purchase fish from this new source and therefore face food insecurity.
- The indirect effects of depletion on employment in the fishing industry given the size of the workforce (as discussed above) could be moderate, but would likely be mitigated somewhat by transition to other sectors.

What are the proposed benefits of mosquito net fishing, and do researchers have a strong opinion on how these weigh against the harms?

In both her conversation with GiveWell, and her published work, Rebecca Short expresses her opinion that there may be benefits to MNF that should be weighed against the harms. For example, in Short et al. (2018), the authors write: "It is worth considering, therefore, the critical importance of understanding the user groups for MNF and their vulnerability alongside

[12] More specifically, the World Bank's Living Standards Measurement Surveys and Integrated Surveys on Agriculture (LSMS-ISA) for Malawi (2016–17), Tanzania (2014–15) and Uganda (2010–11).
[13] These countries are: Egypt, Ghana, Kenya, Malawi, Nigeria, Tanzania, Uganda and Zambia.

empirical assessments of their impacts on a fishery. Strong arguments exist for an underestimated importance of the harvesting of small bodied fish in subsistence communities".

However, we have not found any other research that explicitly calls out the potential benefits of MNF. Tilley et al. (2019), which Short co-authored, calls for more research and acknowledges that "small fish, eaten whole… have the potential to contribute significantly to curbing malnutrition in much of the developing world", but stops short of stating that this is a reason that MNF should continue. The paper is cited by six further articles, according to Google Scholar, and none of these appear to support the use of MNF based on their titles.

We spent significantly less time investigating the potential benefits of MNF, versus investigating the potential harms. From first principles, **it seems plausible that the fish caught through MNF have benefits, though we remain uncertain, and we have tried to indicate these sources of uncertainty below.**

- A 2023 report from the FAO, Duke University, and WorldFish states that fish are an important source of micronutrients for women and children. Fish consumption is associated with lower rates of stunting, and whole, small fish species improve the diets of women and children (pp. 166-167). So, increasing access to these micronutrients may be a key benefit of MNF.
    - However, it's unclear what proportion of any catch from MNFs goes to women and children. It's possible that the split may be lower than expected: the report indicates that in Nigeria, men generally consume more fish from small-scale fisheries than women (as expressed by a gender advisor on page 138, and in gender-disaggregated data on page 173).
- If it's the case that access to mosquito nets increases female participation in fishing, then this may more directly increase fish intake by women and children, as well as autonomy. This is the argument made by Short et al. (2020), who cite evidence that women with access to fisheries resources provide better childhood nutrition than exclusively male-provided households.
    - However, the authors' assessment that women have become more likely to be involved in fishing due to increased efficiency of MNF appears to be based only on observation of coastal villages in Mozambique, and it's not clear how generalizable this is to other locations.