Full title: Protecting fish and farms: incentivising adoption of modern fish-protection screens for water pumps and gravity-fed diversions in Australia

Short title: Incentivising modern fish screening in Australia

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Abstract

Modern fish-protection screens offer significant potential benefits for Australia. The Commonwealth and New South Wales (NSW) governments have invested over $30m to incentivise early adoption by water users. However, successful adoption requires an understanding of the motivations and abilities of water users, and strategies to overcome key barriers to adoption. Four practices have been used in NSW to strengthen understanding of stakeholders and encourage participation in incentive programs by water users. These are: apply social learning concepts to screening programs; evaluate stakeholder needs; identify and map stakeholders and their relationships; and, integrate science in communication and engagement. Analysing the motivations and abilities of water users revealed three key motivations: to save money, to protect fish, and to improve their reputation or social licence to operate. However, the ability of water users to install a fish-protection screen was found to vary significantly. We collate the range of barriers identified by water users in NSW, together with the solution or strategy we have used to address each one. Today, in Australia, over 36,000 ML/day of water is being delivered through modern fish-protection screens, protecting an estimated 580,000 native fish annually at 31 sites across NSW, Victoria and Queensland (60% being in NSW). Existing investment should see these numbers increase to approximately 126,000 ML/day and 1.1 million native fish/yr by June 2024. Application of the methods to understand and strategically engage with stakeholders should enable improved uptake of screening technologies in other jurisdictions and areas of conservation implementation into the future.

Keywords

Diffusion of innovations, fish conservation, incentives, social licence.

Introduction

Modern fish-protection screens for water pumps and diversion channels have the potential to provide significant triple-bottom-line benefits for Australian ecosystems, economies and communities (Boys *et al.*, 2021). Self-cleaning, retractable designs can protect up to 90% of native fish currently being lost to water diversions, reduce damage to water infrastructure, save water, lower energy use and stimulate regional economies through manufacturing, installation, and fisheries tourism. The technology represents a new best practice for industries seeking to reduce their ecological footprint while maintaining access to water, which underpins their profitability. Screening 4,500 pumps in New South Wales (NSW) alone would protect millions of native fish annually and generate a AUD$3.7b boost to regional economies (Rayner and Boys, 2020) and similar benefits are possible in other States and Territories.

Realising the full benefits of modern screens depends on widespread adoption by water users. Adoption might be achieved via regulation, incentivisation or a mixed-model approach combining both regulatory mechanisms and incentives (Selinske et al., 2017). While regulation may seem a simple solution, because it removes stakeholder consent, international experience shows it is relatively ineffective and can actually act as a barrier to adoption in the case of modern fish-protection screens (Baumgartner and Boys, 2012). High-priority water diversions that cause significant impacts to fish can remain unscreened due to exemptions based on 'minimum-size-of-diversion' and 'grandfather' clauses that only require new diversions to be screened, combined with a high demand on resources for enforcement. Regulation also does little to answer the question, "Who pays?". This may lead to negative outcomes, such as the installation of low-quality screens, to satisfy 'green tape', which later require replacement.

In Australia, incentivisation of screening has been the preferred method to begin driving uptake of modern screens. The Commonwealth Government has invested AUD$26m in the northern Murray-Darling Basin (MDB) and the NSW Government has invested AUD$13.5m in the Macquarie River valley. Smaller incentive schemes have also been funded (NSW Government, 2022). Today, over 36,000 ML/day of water is being delivered through modern screens during the irrigation season, protecting ~580,000 native fish annually at 31 sites across NSW, Victoria and Queensland (60% being in NSW). These numbers are expected increase to 126,000 ML/day and 1.1 million native fish/yr by June 2024 (Figure 1).

Additional investment of AUD~$25m could bring the cumulative total to over 3 million native fish/yr by late 2025, depending on manufacturing capacity and river conditions. The number of fish protected will then be approaching the ~5-8 million stocked annually from around 30 hatcheries in NSW, Victoria and Queensland (Gillanders *et al.*, 2006).

The early success of incentive programs can benefit greatly from a strong understanding of stakeholders. Proponents need to know who their stakeholders are, how their stakeholders relate to one another, and how information flows through their stakeholder network. They also need to know what motivates (or demotivates) different types of stakeholders, what abilities different stakeholders have, what might trigger stakeholders to act, and how to address important barriers to stakeholder adoption. Proponents can then design and prioritise scientific research, and communication and engagement activities, that build stakeholder consent and capacity. As empirical data of return-on-investment improves, the level of incentivisation may be adjusted using subsidy or co-pay approaches.

However, developing a strong understanding of stakeholders can be challenging. Specialised expertise and dedicated resources are required – often beyond the skills and resources of proponents. Here, we describe four practices that we have used to strengthen screening programs in NSW over the past decade. These are: 1. apply social learning concepts described by Diffusion of Innovations theory to screening programs; 2. evaluate stakeholder needs; 3. identify and map stakeholders and their relationships; and, 4. integrate science in communication and engagement. Our hope is that these practices, and our lessons learned, might help other proponents to establish and communicate their own incentivisation programs – as they work towards protecting their first million native fish per year.

Apply Diffusion of Innovations Theory

Setting out to screen every diversion in a jurisdiction would be a daunting task. Questions arise, such as how can thousands of individuals and organisations be encouraged to adopt the technology? What levels of investment and prioritisation of water diversions for screening is required? And so on. Central to our progress in NSW has been our application of a concepts described by Diffusion of Innovations Theory. Diffusion of Innovations (DOI; Rogers, 2003) is a classic conceptual framework that explains how and why a new idea, behaviour or technology spreads through a population of stakeholders (Figure 2). It theorises five types of stakeholders, differentiated by how quickly they are likely to adopt an innovation – their innovativeness. DOI then divides a population of stakeholders based on these five types.

1. **Innovators** (2.5% of the population). Enthusiastic adopters of the latest technologies and ideas, ready to try new things.
2. **Early adopters** (13.5%). Those receptive to change and often considered opinion leaders in their communities.
3. **Early majority** (34%). Stakeholders who value evidence and the experiences of early adopters before 'buying-in'.
4. **Late majority** (34%). Relatively sceptical unless faced with a risk of missing out entirely. Require more effort to encourage than the early majority.
5. **Laggards** (16%). Very conservative stakeholders that may never adopt and prove difficult to sway.

DOI describes a range of useful principles for proponents of modern fish screens. However, the key message is that you do not need to work with or convince every water user to adopt. Instead, focus on the innovators and early adopters. These groups are socially-influential (see following sections), more willing to take risks, and more motivated by the kudos, or financial and fringe benefits that can come from adopting early. To 'get off on the right foot', Dearing and Cox (2018) recommend: purposively choosing which stakeholders to work with initially; carefully selecting the locations in which to start your program; and, appreciating what level of early uptake to expect. By recognising that stakeholders vary in their innovativeness, proponents (and funders) can be assured that innovators do, in fact, exist in their stakeholder population, and that early uptake is possible. Proponents can focus on identifying and increasing the capacity of those groups, while avoiding wasting time trying to convince laggards. Similarly, appreciating that innovators are excited by novelty, proponents can tailor their key messages accordingly.

In NSW, we have been applying DOI concepts to screening for over a decade. Our focus has been on using strategic dissemination – how we communicate and engage with water users and other stakeholders to initiate implementation (see Dearing and Cox, 2018). During this time, we have learnt the following valuable lessons in NSW, which could be applied to screening in other areas.

- Adopt a long-term approach, taking time to carefully consider how, where, when and to whom screens (and incentive programs) are promoted.

- Identify and work with innovators (including scientists, anglers and screen manufacturers), to drive development of screens that are tailored for local waterways, water users and fish.
- Define the total size of the stakeholder population (i.e., the number of water licence holders), then estimate the number of early adopters. Scale proposals for funding to suit.
- Build general awareness of screening benefits among water users, and provide them with opportunities to self-select for implementation incentives (e.g., an expression of interest).
- Engage directly with the most 'impactful' stakeholders (i.e., champions of the technology, and influential water users) to build consent for screens at high-volume water diversions.
- Create productive partnerships. Work with early adopters to establish showcase sites that demonstrate the benefits of screening under local conditions using local voices.
- Establish collaborative governance structures that involve stakeholders with broad expertise and experience, including water users, to guide consistent approaches across jurisdictions (e.g., we developed the Australian Fish Screening Advisory Panel).
- Build awareness of your implementation goals among policy and decision makers. Engaging with these stakeholders early in the process provides opportunities for them to 'own' and promote incentive programs.

A critical caveat in DOI is that most innovations fail once 16% of the population is saturated (i.e., the innovators plus early adopters). Moving into the early majority (termed by economists as 'crossing the chasm' of diffusion; Rogers, 2003) will need local showcases detailing the outcomes experienced by early adopters to build a strong case that overcomes more firmly-held objections. Here, research proving the return on investment is important, as is genuine communication that frames evidence in relevant and realistic ways. Proponents who do not understand the return on investment for stakeholders risk applying ineffective incentives, unsuitable messaging, or both. This is where understanding water user needs is essential.

Understand water user needs

All stakeholders have needs. These needs are determined by their motivations and abilities. What type of DOI stakeholder are they? Are they ready to install a modern fish-protection screen? If not, do they need support to improve their understanding of how screens work or the benefits of screening? Do they need to know how a screen might meet their specific needs (e.g., a sustainability certification), and align with triple bottom line outcomes? Are they motivated, but lack the ability to install a screen? Do they need money to pay for installation? Do they need project management support because they are too busy to take on another project? Can they help drive the uptake of screening more broadly, by using their social or financial capital?

The Motivation and Ability Framework (MOTA) is a social research method that provides a framework for proponents to understand the needs of their various stakeholders and answer the questions above (Conallin *et al.*, 2022, Quan *et al.,* 2019; Figure 3). Proponents ask what motivates different types of stakeholders (positively or negatively) and examine whether stakeholders have the capacity to adopt a new idea or technology. MOTA includes assessment of the triggers for, and barriers to, adoption by stakeholders and can be combined with mapping of stakeholders (see next section). It provides a guide for proponents to begin developing engagement approaches and communication actions (e.g., types of meetings amd key messages used) to improve stakeholder consent and capacity – for the different types of stakeholders – ultimately driving delivery and uptake of their technology or idea.

In NSW, we have used MOTA to strengthen our current initiatives and develop new screening incentivisation programs. Our approach has been to use a simplified version of MOTA that focusses on discussions with high-priority irrigators, fisheries managers, government staff, decision makers and screen manufacturers. To date, 20+ on-farm meetings have been held with around 60 irrigators to promote the concept of screening, understand water user operations and concerns, and ‘sign-up’ water users to participate in the program (plus over 80 other stakeholder interactions). During this process, we have applied a variety of engagement approaches and refined our key messages by seeking and incorporating feedback from stakeholders themselves (i.e., by asking them what they need and how they want to be engaged).

Our use of MOTA has generated some important insights in relation to stakeholder motivations, abilities, triggers for action and barriers to adoption. Firstly, water users share

three main motivations with respect to screening. These are to: make or save money; protect native fish; and, improve their social licence to operate.

- **Protect native fish.** Modern screens are proven to protect up to 90% of native fish at an individual diversion. Every screen protects fish and there are cumulative benefits to screening multiple pumps in a single river reach (see Boys *et al.*, 2021a for explanation). Most water users want to protect native fish and improve recreational fishing.
- **Save money.** Modern screens eliminate virtually all debris from diverted water (except fine silt and sand). This reduces the need to backflush pumps, replace inline filters and unblock sprinklers (benefits all reported by early adopters). Stakeholders recognise the savings in energy consumption, staff time and replacement of parts and/or whole pumps.
- **Enhance reputation.** Modern screen installations demonstrate water users' commitment to Environmental, Social and Governance (ESG) goals and intergenerational equity through responsible custodianship of ecosystems. ESG commitments represent a competitive advantage for businesses and are required by some retailers of agricultural products (i.e., supermarkets). Stakeholders can use screens to maintain and enhance their overall social licence to operate. Early adopters have already reported benefits to their public profile and general reputation (Shane Smith, Water Operations Manager, Trangie-Nevertire Irrigation Scheme *pers. comm.*).

Secondly, the abilities of water users vary depending on their abilities, from financial and institutional to technical and social. We have found that water users in the MDB have strong abilities in four ability categories.

- **Financial.** The financial ability of irrigator groups and individuals is generally good. They have shown that they willing to invest in business initiatives, technologies and partnerships that are profitable and sustainable (e.g., tractor technology). Some water users have financial capacity to purchase and install modern screens without government funding. However, in most cases financial support is needed to drive initial adoption of screens.
- **Institutional.** Irrigators are generally well organised, well connected to one another and have governance and financial structures in place to handle contracting and other

agreements. Irrigator groups and individual irrigators in the Murray-Darling Basin have the institutional capacity to participate in modern screen installations. Further, local associations of water users can facilitate discussions and agreements with their members.

- **Technical.** Irrigation technology in the Murray-Darling Basin is well developed and modernised with a high-technology basis. Automation is common and the technical capacity of irrigators and local irrigation support services is high (e.g., pump suppliers, mechanics, installers). Irrigators are accustomed to high-tech products and well-proven solutions that integrate well with their existing operations.

- **Social.** Irrigators are well connected socially across their industries and local communities. Irrigators share their interpretations and opinions of a situation or technology. During our MOTA field work, irrigators told us that they had been in contact with each other during the engagement process (i.e., between meetings) and had already made some conclusions about what their stance was in relation to the program. During conversation they were polite, attentive and generous with their perspectives, and willing to share their opinions with others in order to progress the project.

Thirdly, triggers for action are mostly related to government funding and outreach efforts. Many of these triggers are also linked to, and interact with, the motivations of individual stakeholders.

- Government outreach and engagement. We have been actively promoting adoption of modern screens by water users. While not a traditional MOTA trigger, this activity has been the first and most important trigger for water users to date.

- Support for complementary measures. Some irrigators reported that they did not want to ‘lose any more water through buy-backs’ for environmental flows. They viewed measures like modern screens as a tool to maintain water for agriculture while still meeting environmental objectives.

- Social licence to operate. Large Irrigators (especially cotton farmers) wanted to change their ‘bad reputation for not looking after the environment and water resources’. They saw modern screens as one way to achieve this.

- Screening 'may become compulsory'. Some irrigators think government will make modern screens compulsory and want to act prior to any future legislative change.
- Potential cost savings for specialist irrigation. Backflushing and blockages are costly to irrigation enterprises, particularly those that use specialist drip or pivot sprinkler systems. Modern screens are a potential cost-saving measure.
- Economic stimulus funding. Irrigators recognise that financial support is available now, in the initial phases of diversion screening, and that funding may not be available in future.
- Timing (delay and opportunity cost). This trigger is linked to others, with irrigators wanting to take advantage of incentives currently on offer, and wanting to enhance their reputation as 'green' and 'sustainable'.

And, lastly, a series of common barriers to adoption exist. These include water user concerns about water supply, pump efficiency, ongoing maintenance costs and ownership, a mistrust of government and a lack of experience with fish and debris impacts. We have worked for 10 years to develop solutions to each of these barriers (Table 1). Some of the most common ones are as follows.

- Risk to enterprise: loss of pumping ability, interruption to water operations and breakdown of screens. This is the key concern where funding is available.
- Costs: initial installation, lifespan, and ongoing maintenance (e.g., access to screens, replacement of parts). This is the key concern where funding is not available.
- Lack of trust in government: past failed and/or currently stalled government programs (including those seen as short-term or politically-motivated projects).
- Ownership: concern that ownership of an installation project might lead to reduced capacity to undertake other farming duties (i.e., the burden of project management), plus long-term potential for this asset to become a liability.

Overall, almost all water users are keen to receive information on fish screens that addresses barriers to adoption (Nayeem and Pawsey, 2020 and unpublished data). They are interested in the data on fish losses, if a screen might suit their operation, what the value proposition is (in terms of reliability of water supply, energy savings, native fish benefits and social reputation), and to be provided with connections to screen suppliers and installers. Proponents can employ authentic communication and engagement to deliver this information.

This includes working to address barriers through new scientific research, by demonstrating the experiences of early adopters and by collaborating with manufacturers. Though this process, water users can access opportunities to participate in the development of screening programs.

Identify and map stakeholders

Identifying stakeholders is critical. Proponents need to know who their stakeholders are before they can start prioritising and planning engagement efforts. In NSW, we identified three broad types of stakeholders for screening incentive programs using expert elicitation workshops. These stakeholders are: implementers, influencers and facilitators. It should be noted that DOI can be applied primarily to implementers (those installing screens), but also to other types of stakeholders that vary in their innovativeness. Further, these categories could be applied in other areas where screening programs are underway or proposed. Lastly, proponents might recognise themselves in each of the three groups.

- **Implementers** are the water users directly impacted by screening programs. They are directly involved in implementation (i.e., installation of screens) and therefore have a high level of interest in the nature and delivery of incentives. This type of stakeholder includes individual irrigators, corporate irrigators, irrigation schemes, urban water providers and other water users (e.g., golf courses).
- **Influencers** are stakeholders with a high level of control over the success or failure of screening programs. Their actions can accelerate, catalyse or delay progress and influence the way that incentive programs are managed. This type of stakeholder includes screen manufacturers (current and future), fisheries and natural resource managers, government executives, relevant decision makers (i.e., Ministers) at state and federal levels, and agencies with responsibilities for infrastructure, water, agriculture, fish and the environment.
- **Facilitators** are stakeholders with a high capacity to support and enable screening programs. They can help build awareness among water users and the general public, provide support for engagement activities and coordinate water users at local scales. This type of stakeholder includes champions (including water users with modern screens already installed), farming associations and lobby groups, conservation organisations, fishing peak bodies and other community groups.

Stakeholder relationships can then be mapped. Proponents can group stakeholders based on shared interests, goals, motivations and values (e.g., irrigators, fishing groups and government departments). Links can be added to represent the variety of relationships between stakeholders, ranging from informal social contacts to formal governance arrangements. This process helps proponents visualise the number, type and strength of relationships between different stakeholders and how information might spread through their stakeholder population. This improves the efficiency of engagement efforts, by helping to identify the most important targets for communication. The process also helps proponents consider how conflict might be avoided and collaboration encouraged.

In NSW, initially we used expert opinion and mapped stakeholders using two methods: social capital mapping (Hearne and Powell, 2014) and motivations and abilities mapping (Conallin *et al.*, 2022). These methods revealed: (1) the network of relationships and lines of communication between stakeholders; and, (2) which stakeholders hold similar attitudes or positions on screening and might play similar roles in relation to our incentive programs. Our initial social capital mapping indicated that there were well established groups of stakeholders, which were linked to one another in by interest, sector, and responsibilities. Clear opposers and supporters of screening were also identified based on their motivations and abilities.

The insights gained through mapping allowed further refinement of our stakeholder engagement approach. Specifically, we used these maps to help decide which stakeholders to engage with first, and what information to present (tailoring information to their interests). We prioritised stakeholders for engagement based on three factors: maximising uptake (how can the most screens be installed in the next three years and how can the biggest benefits be delivered?); study area (are the stakeholders physically located within the study area?)' and, receptiveness (which stakeholders are most likely to be motivated to install a screen and be receptive to engagement?). We then tailored the key messages we planned to present, prior to undertaking stakeholder engagement (i.e., contacting stakeholders directly or presenting information to stakeholders indirectly).

Integrate science with comms & engagement

We have worked to integrate science with communication and engagement efforts. We define this integration simply as, 'undertaking science that generates strong, evidence-based key messages and that also responds to stakeholder needs for information'. This involves taking

communication from the end of the project timeline and embedding it into the scientific practice of the project itself. It represents a transition away from the deficit model to dialogue and participatory models of stakeholder engagement. Through a DOI lens, such integration involves deploying communications backed by science to engage early adopters, documenting their experiences, and then using *that* information to 'cross the chasm' to the early majority. There is also a dynamic wherein late majority and laggard stakeholders begin to see the experiences of innovators and early adopters, although this is difficult to quantify.

In NSW, we have been increasingly integrating science with communication and engagement in our screening programs, and we have learnt the following lessons.

- Test key messages to provide nuance and framing that suit different audiences. Emphasise relevant benefits – irrigation efficiencies, biodiversity protection, economic or social good.
- Utilise early adopter experiences by establishing 'showcase' sites that demonstrate the benefits of screening in accessible language using a diversity of voices.
- Prioritise communication that helps establish relationships, build trust and provide 'continuity of care'; rather than 'town hall' meetings that can become distracted.
- Utilise existing networks (e.g., water user associations) that allow stakeholders to self-organise, by partnering with advocacy, industry, and community groups.
- Seek and respond honestly to feedback from stakeholders, particularly in relation to new and emerging knowledge gaps. Answering these questions will help 'cross the chasm'.
- Similarly, adapt to new information. Incorporate knowledge (e.g., from science or MOTA activities with stakeholders) into the management and delivery of screening programs.
- Conduct high-quality evaluations of screening costs and benefits (economic, environmental, social and cultural) to quantify and clarify the value proposition.
- However, be solution oriented early. Use the evidence that is available (e.g., on fish losses and the availability and benefits of modern screens) to take action.
- Anticipate the information needs of industries and decision makers, providing data in accessible language and formats. Identify emerging communication opportunities.

- Assist manufacturers in developing screen technology, by providing up-to-date specifications and clear guidance for native fish protection.
- Establish structures that inform decision makers and support interactions between screening agencies and jurisdictions, guiding new actors as they join programs.

Conclusion

Modern fish-protection screens on water pumps and gravity-fed diversions offer a range of public and private benefits. However, the technology is a new concept for most water users in Australia. Like any new idea or innovation, significant effort is required to raise awareness of incentive programs and generate uptake. Proponents need to develop a strong understanding of their stakeholders and work with innovators and early adopters (*sensu* Rogers, 2003) to address the barriers to adoption faced by both these groups and more sceptical stakeholders. Using local showcases paired with rigorous, responsive and integrated science and clear communication, tapping into social learning, understanding connections, utilising champions and building real relationships will help modern screening cross the chasm of diffusion and establish the use of this technology as a standard best practice in Australian water use. These methods also have significant potential for application in other areas of implementation across conservation management.

Acknowledgements

The authors acknowledge the Traditional Owners of the lands and rivers where this work took place and pay their respect to Elders past, present and emerging. We thank the recreational anglers of NSW for their support, through the NSW Recreational Fishing Trusts and OzFish Unlimited. We also acknowledge the: enthusiastic participation of farmers and other water users in this study over many years; the contextual understanding provided by our colleagues at Charles Sturt University, Nick Pawsey and Tahmid Nayeem; advice from international experts in New Zealand and the United States with experience in modern screening; and, members of the Australian Fish Screening Advisory Panel. The authors declare no conflicts of interest.

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Figure captions

Figure 1. Past and future expected uptake of modern screen technology in Australia. Charts show: (a) the cumulative number of screening sites; (b) the cumulative volume of water screened; and, (c) the cumulative number of native fish protected per year. These figures represent uptake by early adopters, mostly in the Northern Murray-Darling Basin. The estimated cumulative number of native fish protected per year is based on 3.5 native fish entrained per ML of water extracted and a 90 day pumping season (from Boys *et al.*, 2021). Past data includes all jurisdictions. Future installations and volumes are based on the best available data for NSW, including expressions of interest received by NSW DPI Fisheries from water users. There is clear potential to protect millions of native fish per year. However, progress beyond June 2024 in NSW is dependent on further funding.

Figure 2. Diffusion of Innovations as it relates to modern fish-protection screens. With successive groups of consumers adopting the new technology (shown in black) through time, an innovation's market share (grey) will eventually reach the saturation level. The black curve is broken into sections of adopters. Note the use of an Expression of Interest program to allow innovators and early adopters to "self-select" as participants, and a reduction through time in the amount of incentivisation provided to stakeholders. Research and communications are required to "cross the chasm" of diffusion to the majority of stakeholders, in this case water users. Figure after Rogers (2003).

Figure 3. MOTA framework with explanation showing how it works with screening. The MOTA framework showing the relationships between the trigger for change, how stakeholders perceive the trigger (as an opportunity or a threat), their ability to respond and their motivations to do so. These elements combine to determine what action a stakeholder might take and the resulting outcome. The solid arrows indicate the influence of one element on another, and the dashed arrows indicate a potential influence (e.g., positive outcomes for one stakeholder may trigger another stakeholder to adopt a technology). Barriers are not shown in this figure but are mentioned in the text and relate to stakeholder abilities and perceptions (e.g., a poor opinion of the technology could demotivate a stakeholder, make them identify it as a threat and therefore act as barrier to adoption). Figure after Conallin *et al.* (2022).

481 **Table 1.** Barriers identified by water users in the NSW portion of the Murray-Darling Basin,
482 and the solutions developed and implemented by NSW DPI Fisheries.

Barrier	Solution
Fine mesh screens will get blocked and interrupt water supply or damage infrastructure.	10+ years of local research and development to ensure modern screens do work for native fish species and farming operations. Screens are tailored to individual water diversions and operations, ensuring no impact on pump performance. Concerns that pump performance and water supply would be interrupted have been alleviated by conveying experiences of water users at showcase sites (e.g. Trangie-Nevertire Irrigation Scheme and Porker Citrus).
Financial cost too high (inc. capital, installation, running costs, maintenance and replacement costs).	Identified that water users are unaware of the actual costs of modern screen maintenance, which are significantly lower than traditional screens. Government is providing financial incentives, such as seed funding or total funding, for screen installations to encourage early adoption. This has helped alleviate the financial burden to water users and facilitated uptake by early adopters.
Loss of native fish from waterways not perceived to be real.	Identified that water users are generally unaware of the scientific evidence that is available. Perception exists that the numbers of fish lost from waterways is small, especially relative to the cost of screens ('we see very few fish, and only carp'). Fisheries research shows this is incorrect. There is extensive historical and contemporary evidence indicating native fish losses are in the many millions per year (Boys *et al.*, 2021a). Many stakeholders, particularly peak bodies engaged in the implementation of modern screen technology, accept that fish losses can be significant but vary between diversions.
Trust in governments due to past negative experiences.	Some stakeholders have a general mistrust in governments and perception that government incentivised schemes are risky due to past negative experiences. Some water users feel

	that government schemes can be unpredictable and influenced by ministerial changes ('left holding the baby'). Fears of government volatility have mostly been allayed by the long-term commitment, and long-term experienced staff managing screening programs.
Return on investment perceived to be too low.	There is strong anecdotal support of good economic outcomes from modern screening. However, detailed empirical evidence is required. This knowledge gap is to be addressed through a research project by for an economic analysis of modern screen installations (in partnership with the Fisheries Research Development Corporation and the Cotton Research Development Corporation).
Modern screens perceived to have a short lifespan.	We published guidelines and design specifications for modern fish screens, in partnership with screen manufacturers. These recommend the use of high-quality, stainless-steel wedge wire with a long lifespan. Self-cleaning mechanisms and screen retraction systems, which allow screens to be removed from the water for servicing, also extend the lifespan of a modern screen.
Technology perceived to be unproven or unreliable, or not proven (e.g. break down regularly) and that piloting was risky ("guinea pigs").	Alleviated through showcasing USA, NZ and AU sites where track record is solid. Able to clearly demonstrate that screens are reliable, the science is rigorous and the technology sound. Local demonstration sites provide important proof that modern screens work. Work with reputable engineers to manufacture screens using well-established technologies.
Seasonal aspects and enterprise status impacting engagement and installation activities.	Season and status impact motivation and ability of water users to be involved in ventures that are not seen as core business. The impact of this barrier may be larger for smaller producers. This has been incorporated into engagement by

	acknowledging and working around peak harvest, planting and irrigation times, weather events and commodity prices.
Ownership and championing of the technology. Modern screen viewed as potential depreciating asset, especially if there is no screen fitted currently.	With any new technology, ownership and championing from the intended owners/implementers is key to adoption. Ownership and championing by water users is emerging (e.g. irrigators), taking away any 'sales' stigma of projects and replacing it with credible experts in water supply, infrastructure management and operation.

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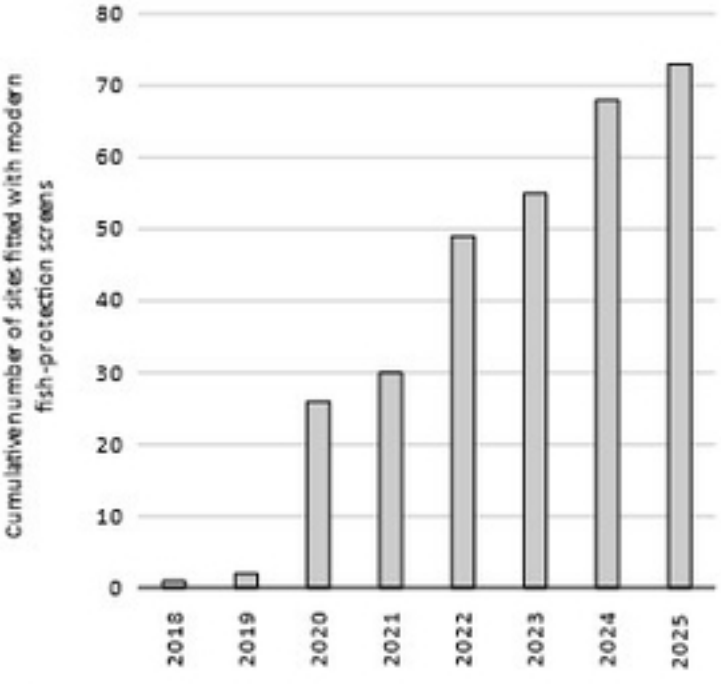
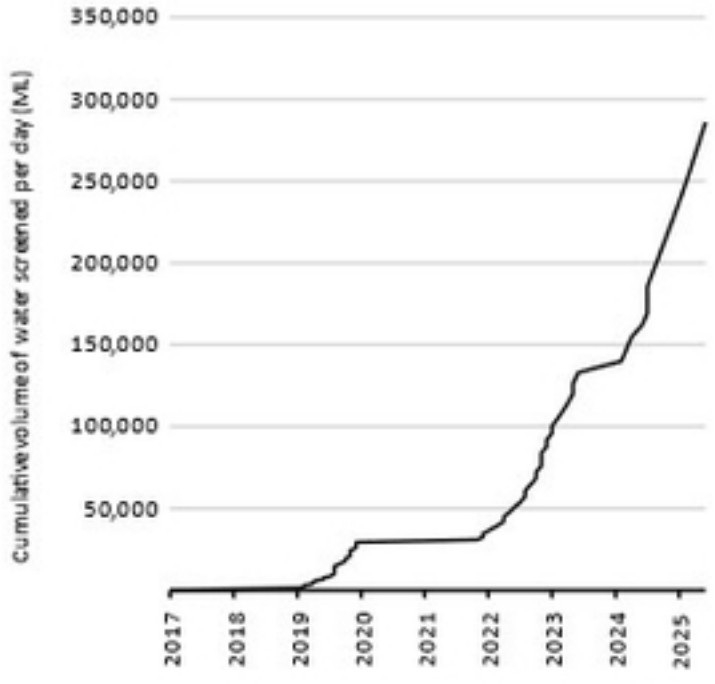
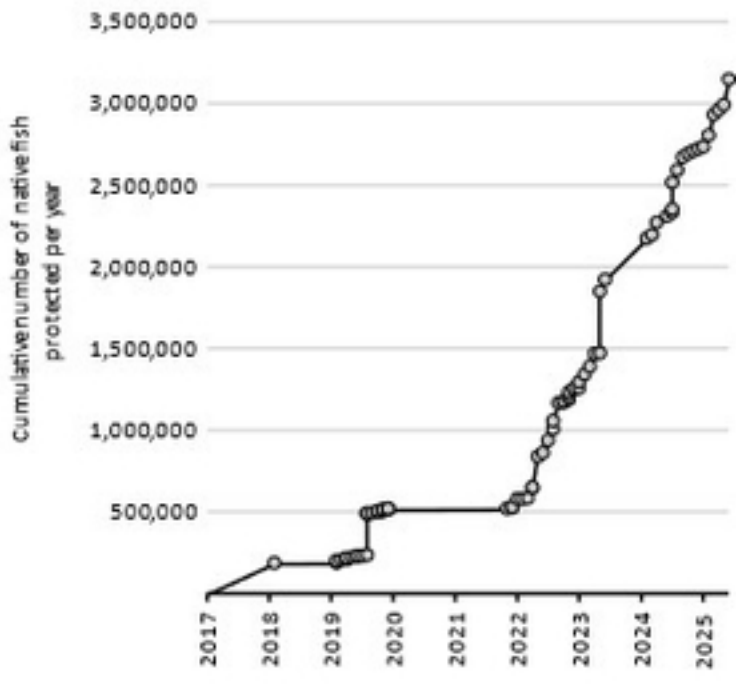
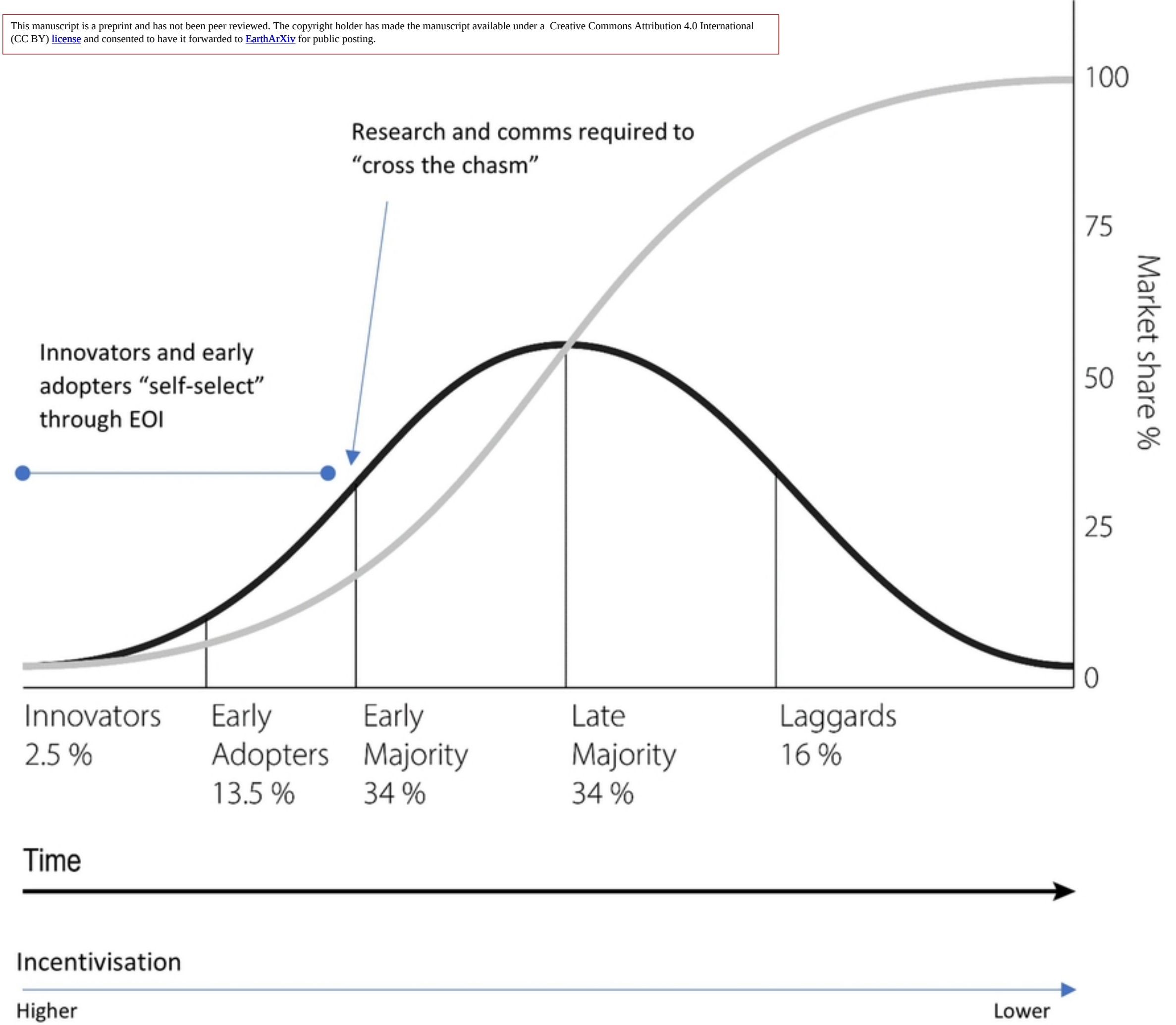

Cumulative number of sites fitted with modern fish-protection screens
80
70
60
50
40
30
20
10
0
2018
2019
2020
2021
2022
2023
2024
2025

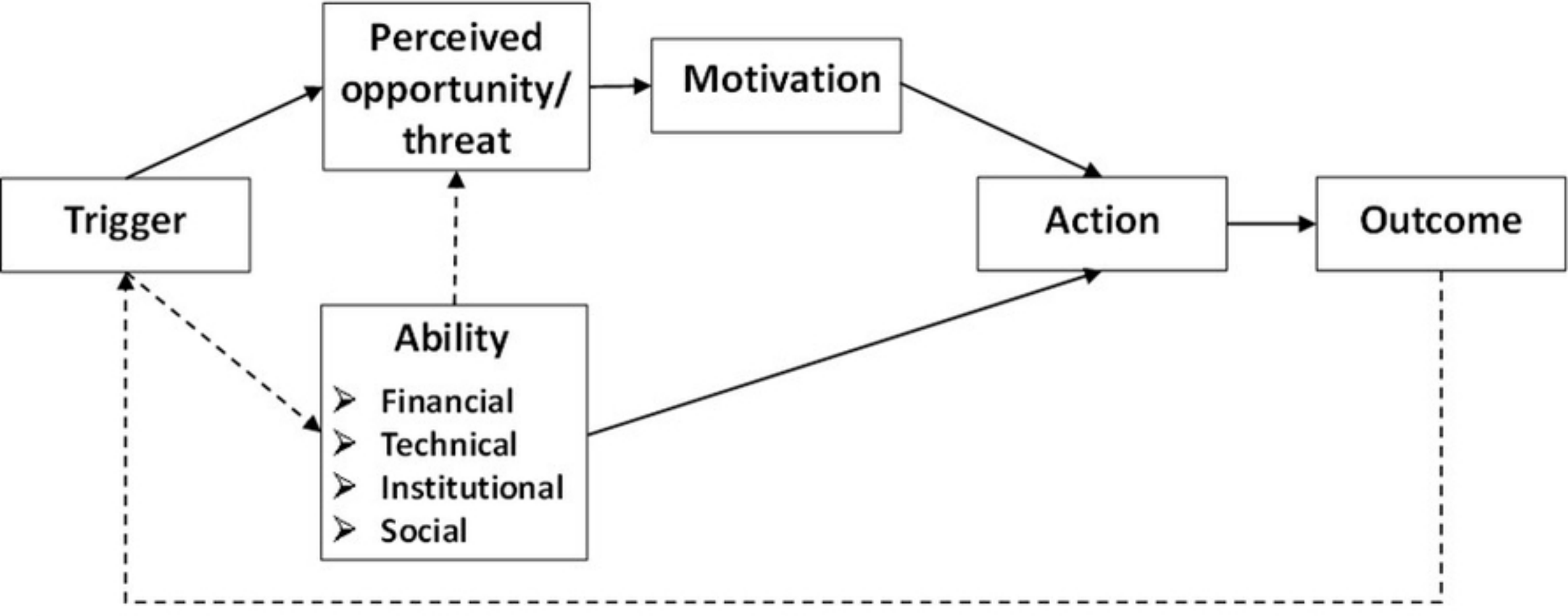

Cumulative volume of water screened per day (ML)
350,000
300,000
250,000
200,000
150,000
100,000
50,000
2017
2018
2019
2020
2021
2022
2023
2024
2025


Cumulative number of native fish protected per year
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
2017
2018
2019
2020
2021
2022
2023
2024
2025

Figure



Figure


Perceived opportunity/ threat
Motivation
Trigger
Action
Outcome
Ability
Financial
Technical
Institutional
Social

Figure