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ORIGINAL ARTICLE

The FishPath approach for fisheries management in a data- and capacity-limited world

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Abstract

Successful fisheries management systems tend to be underpinned by harvest strategies, specifying formally agreed data collection systems, assessment approaches and management measures used to regulate fishing pressure. While harvest strategies can be effective even in data- and capacity-limited (DCL) situations, their development remains challenging in such contexts. We present a process and decision-support tool, FishPath, to guide the identification of suitable harvest strategy component options given often debilitating conditions: (i) resource limitations and lack of technical management capacity; (ii) 'uniqueness' of DCL fisheries; (iii) the concept of harvest strategies is unfamiliar to managers and scientists, and the universe of options is hard to navigate; and (iv) the lack of an effective participatory process to identify solutions tailored to local contexts. These conditions can lead to either management paralysis or generic solutions that may be poor fits to specific conditions. The FishPath Tool uses a diagnostic questionnaire that elicits the key characteristics and specific circumstances of a fishery. It compares these with the requirements of alternative options from an inventory of possible harvest strategy components, identifies where these requirements are met and provides customised, transparent guidance on the appropriateness of component options of a harvest strategy, specific to the fishery of interest and its governance context. The FishPath Process is a facilitated multi-stakeholder, participatory engagement process aimed to set fisheries on the path to develop a harvest strategy. The FishPath Process and Tool combine to ensure a bottom-up, documented, transparent, replicable and efficient process.

KEYWORDS
data limited, decision-support, fisheries management, harvest strategies, management strategies, sustainability

1 | INTRODUCTION

Seafood is a critical animal protein source for nearly 3 billion people, and fishing and processing of seafood products provide direct and indirect livelihoods for hundreds of millions of people (FAO, 2020; Smith et al., 2010). Yet sustainable management of marine fisheries occurs in only a small fraction of the thousands of fisheries worldwide (Costello et al., 2016; Hilborn & Ovando, 2014). The economic, social and biological outcomes tend to be underpinned by harvest strategies (Sloan et al., 2013; Smith et al., 2014; Vieira et al., 2010)—transparent and formal frameworks for managing the exploitation of fisheries, usually applied to the target species (e.g. Butterworth & Punt, 2003; Dowling et al., 2008; Sainsbury et al., 2000).

Harvest strategies specify predefined, consistent and agreed-upon data collection (monitoring) programs, methods for indicating or assessing the status or health of the resource and harvest control rules for adjusting management measures used to regulate fishing pressure as a function of resource status (Figure 1) (Dowling, Dichmont, et al., 2015; Sainsbury et al., 2000). Harvest strategies differ from conventional fisheries management, where the management response is determined by applying a harvest control rule to a 'best assessment' of stock status and where the approach used to deliver the assessment may be adjusted as new data are incorporated (Butterworth & Punt, 2003). Harvest strategies are akin to agreeing to the rules before playing the game and shift the perspective from short-term reactive decision-making to the use of consistent management procedures designed to meet longer-term objectives (https://www.pewtrusts.org/en/research-and-analysis/issue-briefs/2019/11/harvest-strategies-21st-century-fisheries-management).

However, to design a robust and effective harvest strategy is complex as it is not always apparent what rules should be written, as there may be many perspectives to incorporate. Fisheries management thus requires the balancing of multiple objectives, from biological and environmental, to social and economic. These various objectives often do not align and require compromise to integrate them. The adoption of harvest strategies serves to achieve fishery management objectives and find the best balance among objectives. These generally seek to improve multiple aspects of the fisheries management and seafood production, including economic returns, business certainty, job security and community stability while promoting biological sustainability and the conservation of target species, important habitats and vulnerable species.

Harvest strategies have been successfully implemented in many high-value, well-resourced fisheries with strong management, and effective institutional and legislative structures (Costello et al., 2012; Hilborn et al., 2020). However, a significant challenge remains in applying harvest strategies to data- and capacity-limited (DCL) fisheries. We define DCL fisheries as those that have insufficient data (e.g. type, amount and/or quality of) and/or capacity (e.g. research, institutional or funding) to enable a quantitative, model-based stock assessment to be undertaken to estimate time series of biomass and fishing mortality relative to their reference points.

Relative data poverty is explicitly acknowledged within certain management frameworks that assign precautionary buffers around management outcomes from more data-limited assessments. These include the Australian Fisheries Management Authority (AFMA) tiers (Dichmont, Deng, et al., 2016; Dichmont et al., 2017), the Alaskan tier system (North Pacific Fishery Management Council [NPFMC], 2014) and the U.S. Pacific Fishery Management Council stock assessment categories (Ralston et al., 2011). However, many DCL fisheries suffer from ineffective or insufficient management, weak governance structures, limited resources and capacity to develop and implement data collection and monitoring programs, and a paucity of data and information (Cope et al., in review). Significantly, DCL fisheries contribute close to half the volume of global seafood production (FAO, 2018), making their successful management critically important to local and national economies, healthy coastal communities and marine ecosystems.

The components of DCL harvest strategies take diverse forms that vary according to a fishery's circumstances and idiosyncrasies. For example, DCL harvest strategies may rely on empirical indicators of stock status, that is, indicators calculated more or less directly from monitoring data. These can be used singly or combined in multi-indicator frameworks (e.g. Harford et al., 2016, 2021), forming 'empirical assessments'. Empirical indicators or assessments can incorporate local fisher knowledge and give indirect estimates of stock status. Management, in turn, may employ static measures, such as fixed seasonal closures or size limits, or be more responsive to dynamic conditions as reflected by the indicators.

As such, we herein use the term 'assessment' in a broad sense, to embrace any qualitative, semi-quantitative or quantitative process by which performance indicators are derived. 'Assessments' here range from expert judgement and empirical methods, in which

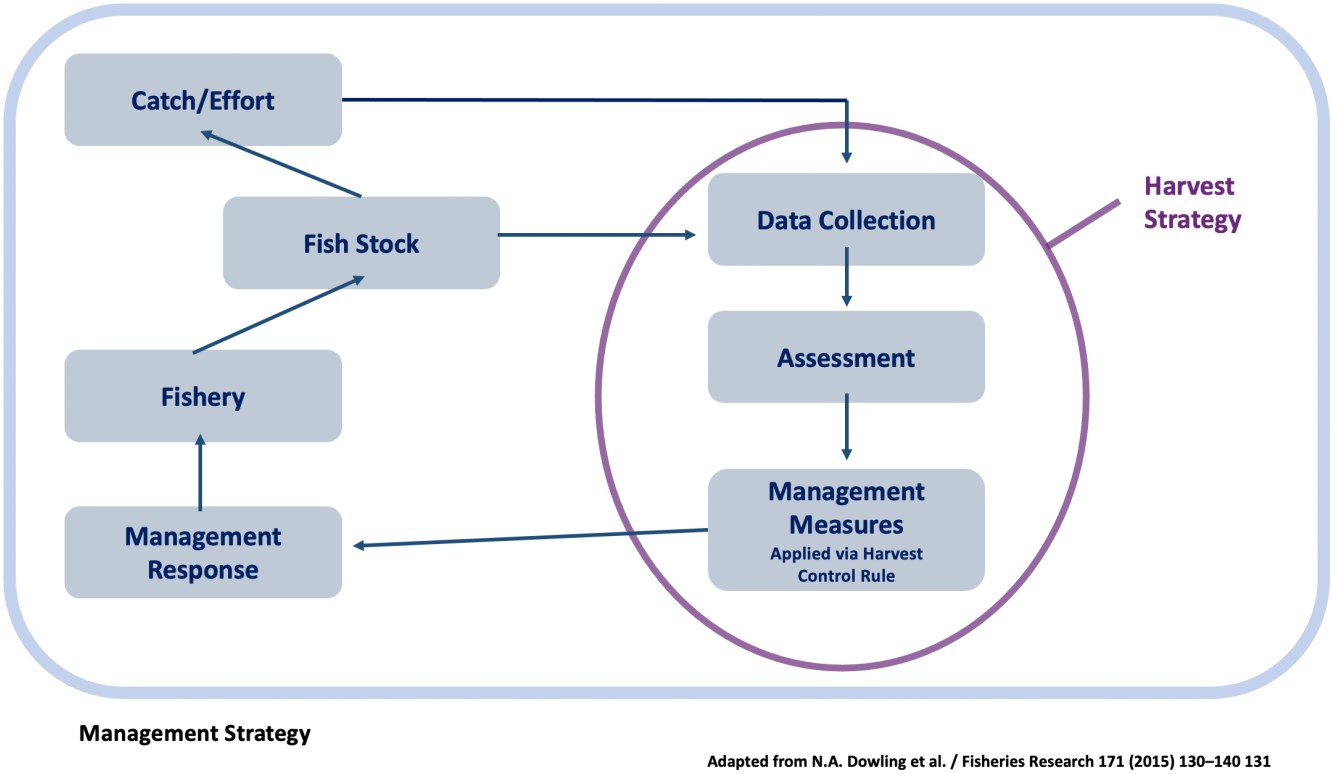

FIGURE 1 The adaptive fishery management cycle, showing the components of a harvest strategy.

performance indicators are based on directly measured properties (i.e. in the absence of any formal analysis or traditional stock assessment), to model-based approaches, where performance indicators are model outputs. Table 1 of Dowling et al. (2019) provides a summary of the types of approaches we class as data-limited 'assessments', including empirical assessments.

There is a large body of literature that provides advice on assessment approaches for fisheries that face data limitations (Carruthers et al., 2016; Chrysafi & Kuparinen, 2015; Dichmont, Punt, et al., 2016; Dowling, Dichmont & Haddon, et al., 2015; Prince & Hordyk, 2018). This literature collectively indicates that science-based harvest strategies can be effective even in DCL situations, particularly if precautionary harvest control rules (i.e. formal rules to adjust management measures given the value of assessment performance indicators relative to reference points) are used within a harvest strategy to reduce risk resulting from uncertainty in assessments (see the FISHE application (http://fishe.edf.org/) for a guided description of this process). Why, then, do most of the world's DCL fisheries continue to lack science-based harvest strategies (Costello et al., 2012)?

2 | CONDITIONS THAT THWART SCIENCE-BASED FISHERIES MANAGEMENT

There are three main sets of conditions faced by DCL fisheries worldwide (though they are certainly not limited to DCL fisheries; many also apply in 'data-rich' cases) that often stall the process of establishing science-based harvest strategies (Figure 2):

1. *Resource limitations and lack of technical management capacity*: Limited technical capacity may inhibit both the training of individuals to identify, select and apply appropriate stock assessment methods and the designing of effective harvest control rules (Cope et al., in review). The implementation of informative data collection programs may also be inhibited by temporal-spatial constraints or by limited funding. Data quality or quantity especially limits the available assessment options and often precludes or hinders the application of more familiar or conventional assessment approaches (e.g. Dowling et al., 2008; Fujita, 2021; Pons et al., 2020). Compounding this, analytical technical capacity to identify, understand and undertake appropriate assessment methods given the existing data quality and quantity with respect to method assumptions (e.g. life-history types, equilibrium conditions or fishery selectivity) and management needs (e.g. catch or effort management metrics), is often very low. This increases the risk of method misapplication or interpretation and, subsequently, erroneous advice to managers.
2. *Associated characteristics and 'uniqueness' of DCL fisheries*: DCL fisheries tend to have other characteristics, which are often structurally correlated with data limitations (Cope et al., in review; Dowling, Dichmont, et al., 2015; Parma et al., 2003). DCL fisheries may have dispersed landing sites with little or no infrastructure,

TABLE 1 Illustrative sample subset of options contained in the FishPath Tool for each of its 3 sections (data collection, assessment, management measures)

Illustrative options		
Data collection (50 total)	**Assessment (49 total)**	**Management measures (40 total)**
Local expert knowledge	Analysis of change in a single (non-CPUE) indicator	Minimum legal size
Port/landing-site monitoring	Use of biomass surveys to inform spatial management	Gear restrictions, by selectivity
Formal logbooks	Multiple indicator frameworks: Hierarchical decision trees	Daily trip limits (bag limits), with or without TAC
Independent surveys: By researchers, performed regularly	Depletion-based stock reduction analysis (DB-SRA)	Implement a spatial closure in response to assessment outcomes
Electronic monitoring: Vessel cameras	Length-based spawning potential ratio (LB-SPR)	Adjust effort according to assessment outcomes, with feedback control rule (empirical target- or trend-based only)
Onboard observers	Production model	Adjust catch according to assessment outcomes, with feedback control rule (target-based with F- or biomass-based reference-point assessments)

Note: The full list of options, including how they are categorised within the tool, can be found in supplementary information S2 (FishPath Options - Sept 20 '22 - Google Sheets).

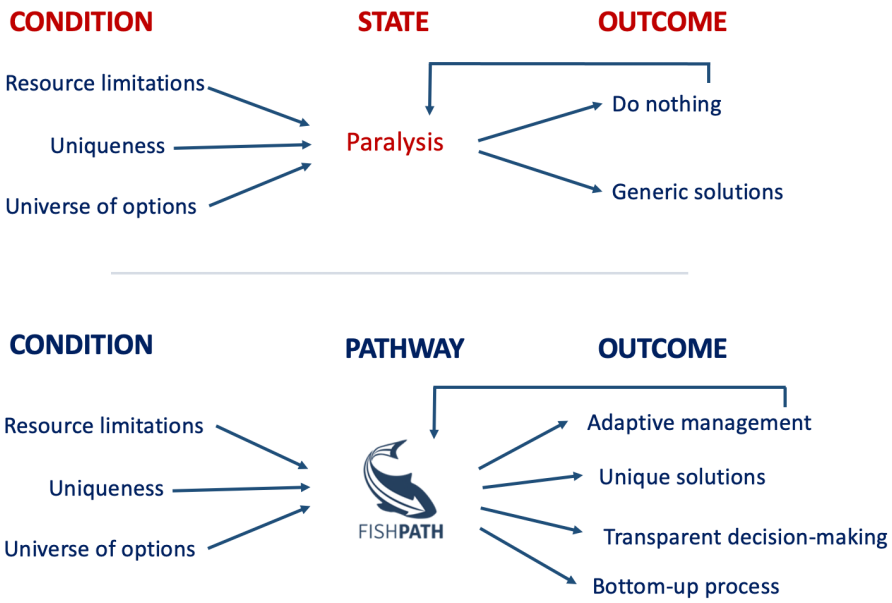

FIGURE 2 Conditions that limit science-based fisheries management (top panel) and how FishPath can explicitly overcome these (lower panel).

often have substantial artisanal and subsistence components, are commonly multi-sector, multispecies or multi-gear and may include diverse and varied targeting and operating practices and numerous, unregulated operators. All of these characteristics can make data collection, monitoring and enforcement difficult. Whilst these characteristics are common, they can manifest in locally particular ways that give a sense of unrelatable uniqueness. As examples, the specifics of each fishery's geographical setting, size, diversity and variability of operations, compliance peculiarities that hinder data collection and enforcement, habitat and ecosystem interactions and competition or competing objectives with industrial fishing sectors can be overwhelming if taken all at once. The overwhelming task of dealing with all of these specific and challenging attributes can contribute to a sense of isolation. Fishery participants and managers may see their situation as so unique and difficult, they are literally alone in facing these unrelatable challenges. Finally, politically driven short-term timelines and competition for resource allocation among government

priorities can prevent sustained investments and needed institutional reforms to promote long-term resource and economic sustainability. Poverty and food-security issues often drive fishing pressure such that long-term objectives are unable to be met due to short-term necessity. These characteristics collectively pose a diverse set of challenges and constraints that need to be considered when designing the data collection, assessment and management options that comprise a harvest strategy.

3. *The concept of harvest strategies is unfamiliar, and the universe of options is hard to navigate*: Formal harvest strategies are largely absent from local and national policy instruments in many regions throughout the world (Melnychuk et al., 2021). Without formal guidelines for harvest strategy design, fishery scientists and managers may approach the management of fisheries by focussing on one or more components of a harvest strategy without explicit linkage between data collection, assessment and implementation of management measures. Furthermore, the set of harvest strategy possibilities is immense, involving empirical assessment options, multiple indicator assessment frameworks (Dowling, Dichmont & Haddon, et al., 2015) or restricted quantitative assessment methods (e.g. catch estimator methods, length-based methods), and the process of selecting context-appropriate harvest strategy options for DCL fisheries can be daunting. Identifying relevant fishery issues and assimilating data to develop a harvest strategy is not trivial (Dowling, Dichmont & Haddon, et al., 2015; Dowling et al., 2008). It is also difficult to coordinate and connect the three harvest strategy components (Data Collection, Assessment and Management Measures; Figure 1). For example, available stock assessment methods are often based on the available data being collected, and technical capacity is required to identify the most appropriate management metrics (e.g. catch or fishing rate) and assessment methods, and how those metrics could drive changes in management measures in a way that addresses the specific institutional needs and constraints (e.g. unable to enforce spatial management, but could enforce gear modifications).

Pragmatic creativity in the face of data paucity or resource limitations tends to broaden the universe of possibilities, offering solutions and adaptive pathways to improve the status quo. However, the need to embrace complexity and avoid over-simplified panaceas (Ostrom, 2007) often results in major roadblocks to management action (e.g. delaying until there is enough data to apply a familiar assessment method) and can lead to inaction and an overall state of paralysis, where the development of a science-based harvest strategy is deemed too resource-intensive, too overwhelming or just plain impossible. In such situations, fisheries management commonly: (1) defaults to a 'do nothing' attitude and/or giving way to the inertia of the status quo; or, (2) seeks out generic solutions seen elsewhere that are implemented without thorough vetting or understanding of inherent limitations and mismatches to specific local conditions (Figure 2). The latter can include defaulting to the recommendations of 'fly-in-fly-out' consultants or experts that are prescriptive and can be biased towards a limited number of assessment or management approaches that are familiar but may not be suited to the specific local context.

The appeal of simple, generic solutions is understandable: when overwhelmed with potential options or lacking the technical capacity to identify or evaluate them, any method that is standard or promoted heavily and repeatedly by consultants or experts can remain a path of least resistance even if it actually is a poor fit to a particular situation upon closer examination. No single data-limited assessment method or management approach, or limited subsets thereof, is appropriate or optimised across all data conditions, fishery operational characteristics, species life histories and socioeconomic or governance contexts (Costello et al., 2016; Dowling et al., 2019; Rosenberg et al., 2014, 2018). The requirements, assumptions, caveats (hence, suitability) and links of each component of a potential harvest strategy need to be understood.

Attempts to develop harvest strategies, however, have often followed limited expert advice or generic prescriptions (Ernst et al., 2013). This carries a risk of bias due to an expert's limited expertise, or inability to simultaneously consider the multitude of possibilities and may lead to the indiscriminate application of unsuitable harvest strategy components (particularly, stock assessments). In addition, failure to involve local stakeholders in the identification of solutions can limit buy-in and support for policy recommendations by local practitioners, even in situations where harvest strategies that are good fits for the circumstances have been recommended. When evaluating and designing harvest strategy options, understanding the full context of each fishery's unique challenges and working with local practitioners to design tailored approaches is paramount to finding the best solutions.

3 | FishPath: A PARTICIPATORY APPROACH TO OVERCOMING CHALLENGES AND DEVELOPING TAILORED HARVEST STRATEGY COMPONENTS

The three conditions that limit the development of tailored harvest strategies need to be addressed in order to identify pathways out of paralysis and towards sustainable management within the resources available to manage a fishery. FishPath (https://www.fishpath.org) is an impartial approach to setting DCL fisheries on a path towards sustainable fisheries management, through supporting the design of context-appropriate science-based harvest strategies. FishPath consists of three key components: the FishPath Tool, the FishPath Process and the FishPath Network. While the early version of the Tool was first described by Dowling et al. (2016), we here provide a broader description of its new features and use, and we emphasise two new aspects of the approach: the philosophical approach to facilitated Tool use, and the building of a community of users to expand FishPath's outreach and extension.

3.1 | The FishPath Tool

The FishPath Tool is an online, interactive decision-support tool that streamlines the process of identifying appropriate options for a given fishery (defined as the stock(s), geographical area, fleets and gear types being considered) for each of the three harvest strategy components: Data Collection, Stock Assessment and Management Measures (Dowling et al. (2016) present an early version). The tool has grown significantly from the Dowling et al. (2016) version in terms of functionality, detailed information and available options (see Supplementary Information S1 for a comparison).

The Tool has a wide variety of utilities, but one of the most salient is for harvest strategy scoping to guide users to a short list of options for each of the three components, that may then be further developed with input from stakeholders for integration in a harvest strategy. The Tool includes a comprehensive suite of options initially developed as a framework under the auspices of a Science for Nature and People Partnership project, involving 22 international experts (2014–2016). Table 1 shows a sample subset of options contained in the FishPath Tool for each of its 3 components (Data Collection, Assessment and Management Measures). The full list of options can be found in Supplementary Information S2 (FishPath Options - Sept 20 '22 - Google Sheets). Regular updates are made from an ongoing review of the literature (e.g. Chrysafi & Kuparinen, 2015; Dowling, Dichmont & Haddon, et al., 2015; Pons et al., 2020), the collective expertise of fisheries scientists and advisors associated with seven fisheries management organisations and non-governmental organisations across the globe (including Australia's Commonwealth Scientific and Industrial Research Organisation, the United States' National Oceanic and Atmospheric Administration and the Nature Conservancy) and feedback from scientists, managers and commercial, recreational and indigenous fishers and other users during implementation.

The Tool is designed to guide scientists, managers and stakeholders through an accessible process to identify and refine appropriate harvest strategy options, and connect these to actions for the current and future states of any fishery. An online user guide has been developed to explain detailed functionalities of the FishPath Tool and may be found at https://fishpath.github.io/FishPath-Tool-User-Guide/ (TNC, 2022). The Tool's strength is organisational as it does not include software to perform any given analytical method (though it does provide links to tools that do so), but rather supports tactical and strategic decision planning and making. It is especially good for illuminating the required fisheries science training so as to focus instruction on methods most relevant to the specific situation, rather than giving more general training courses.

The FishPath Tool uses a diagnostic questionnaire aimed at eliciting the key characteristics and specific circumstances of the fishery including (i) the biology of the species of interest, (ii) the fishery operational characteristics, (iii) the availability and types of data, (iv) the socioeconomic context and (v) the relevant governance systems and policies affecting the fishery (Figure 3, Figure 4) (Dowling et al., 2016; https://tool.fishpath.org/). Table 2 shows a sample subset of questions from the FishPath Tool Questionnaire. The full list of questions can be found in Supplementary Information S3 (FishPath Questions - Sept 20 '22

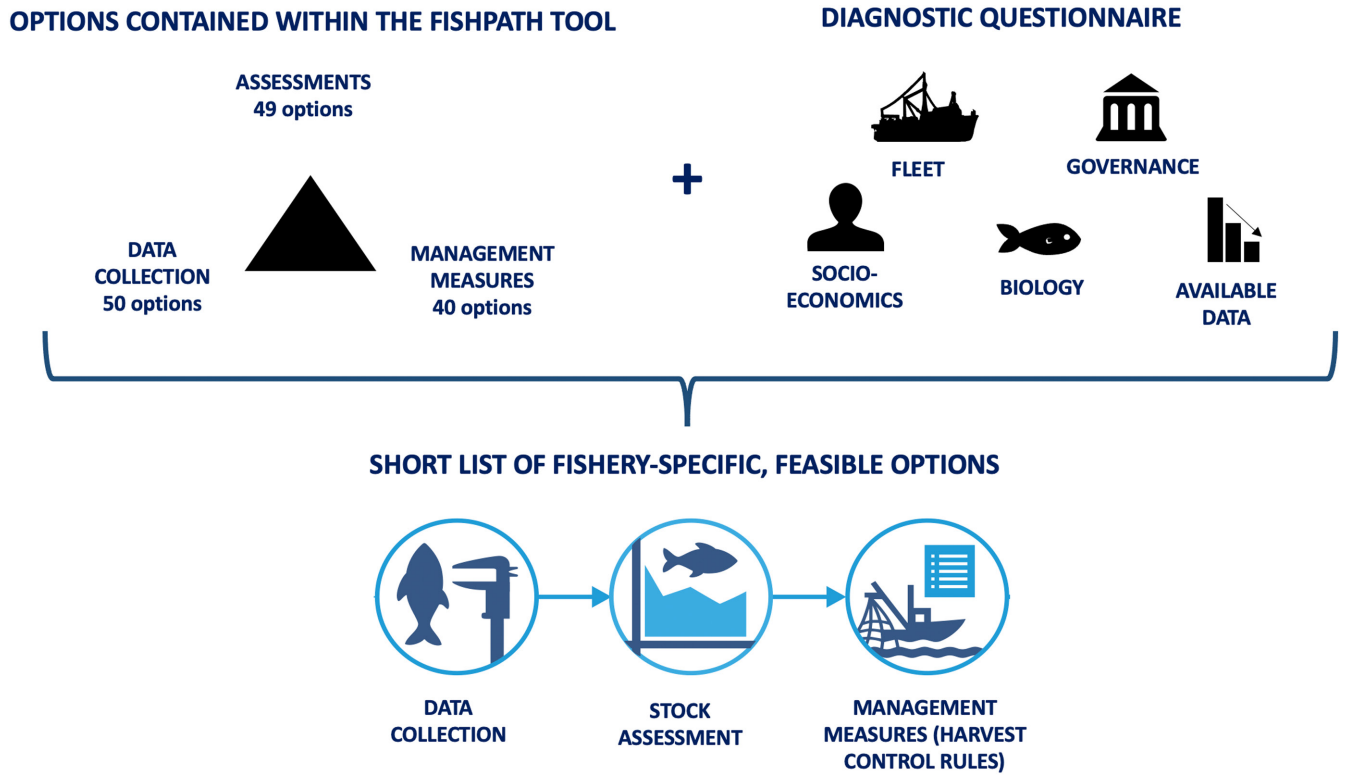

FIGURE 3 Simplified conceptual diagram of the online FishPath Tool.

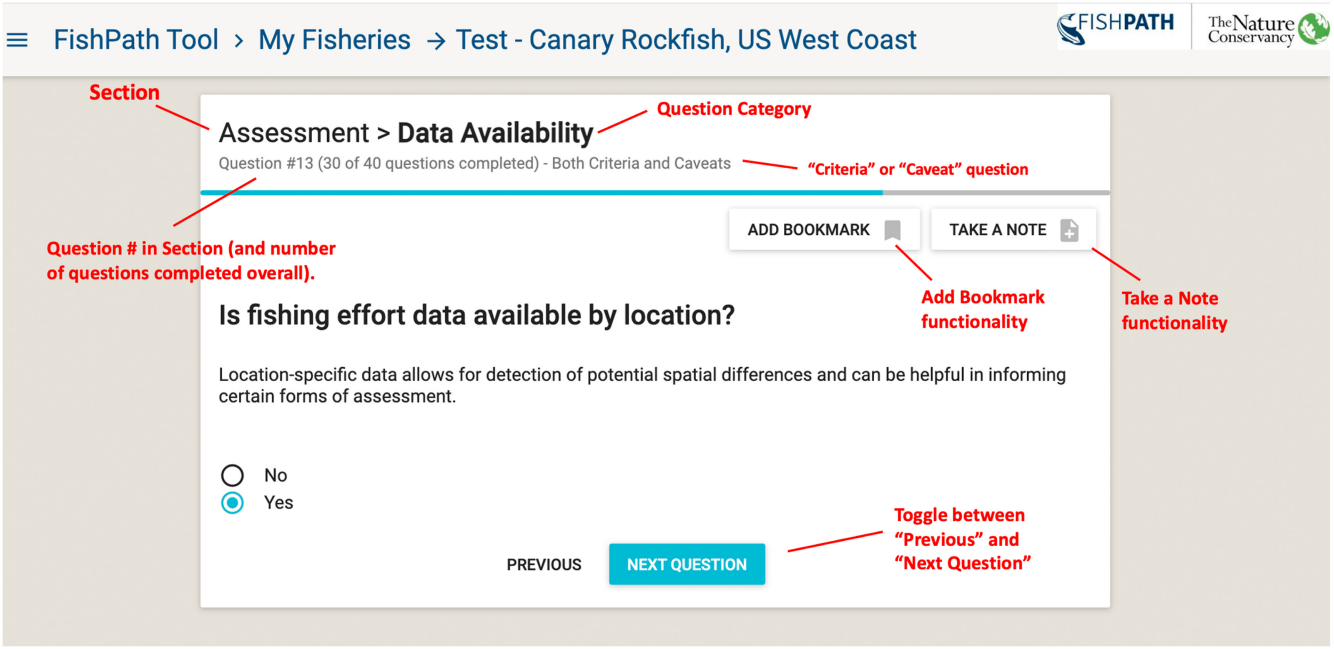

FIGURE 4 Anatomy of a FishPath Tool question. This is a screenshot of an individual question from the online FishPath Tool questionnaire. Red text labels indicate functionalities or other aspects of the question.

- Google Sheets). By including socioeconomic and governance considerations, as well as the more typically considered issues (i.e. data quality and quantity, species biology and fisheries operational characteristics) the FishPath questionnaire embraces a diverse range of aspects affecting a fishery and fished stocks that are relevant to their management. The Tool's intended target audience is primarily managers and scientists, but its diagnostic questionnaire provides an interactive means to also bring fishers and other stakeholders 'along for the journey', whereby they see how their input and local knowledge directly conditions the available options. As such, a greater sense of trust and ownership may be conferred to fishers and other stakeholders.

The FishPath Tool compares the fishery's characteristics with the input requirements and needs of alternative data collection options (the various methods by which data may be collected), assessment methods and management measures, from an inventory of possible approaches (Table 1; Supplementary Information S2) and identifies strengths of selected options where criteria are met and provides cautionary caveats (e.g. possible violation of assumptions) where pertinent (Figure 5 provides a schematic). This is simply a process of confronting the user's questionnaire responses to the objective, minimum requirements, assumptions and caveats associated with each option (Figure 6 provides an example of caveats invoked against three Management Measure options for two questions; Figure 7 shows the presentation of results for one option, and how the user can drill into the details of the invoked criteria and caveats; Supplementary Information S4 (FishPath Content Matrices - Sept 20 '22 - Google Sheets) provides the full linkage matrices for the Tool).

The only subjectivity within the Tool's 'algorithm' is in the users' categorisation of the levels of available research, resources or institutional capacity, and the willingness and reliability of fisher reporting. In such instances, the Tool aligns the assigned categories with recommendations of options. However, the recommendations are directly linked to the question responses and are thus totally transparent to the user (Figures 5–7), eliminating any ambiguity in interpretation, and further allowing the user to adjust responses to view alternative outputs.

The Tool thereby provides customised advice on the appropriateness of any option for the fishery of interest. Key assumptions and considerations that apply to options regardless of fishery circumstance, are also provided as 'static caveats' and should always be seriously considered. The Tool does not include software libraries to undertake any stock assessments or associated analyses, specify reference points against performance indicators, or conduct closed-loop simulations to evaluate harvest control rules (i.e. telling users where or how much to fish given the outcome of a stock assessment). It does set up the discussion of these next steps by providing well-matched assessment methods and management measure options, given the specific conditions of the fishery(ies) and stock(s).

While answering the questionnaire, individual questions can be flagged to revisit later (Figure 4). The Tool also includes the ability for the user to add notes against question responses and individual harvest strategy options, to document any associated discussion and decisions, or clarify the rationale for a response. The impact of any response on the options selected is transparent, with the Tool enabling users to directly compare how alternative responses to any one question impact the invoked caveats and criteria. This

TABLE 2 Illustrative sample subset of questions from the FishPath Tool Questionnaire

Illustrative questions					
Question	**Description**	**Possible answers**	**Data collection**	**Assessment**	**Management measures**
Rank the level of research and institutional capacity to implement a formal harvest/management strategy (i.e. data collection, assessment, management measures)	This question should be answered relative to the agency's or organisation's own context and circumstances. Research and institutional capacity refers to capacity that is either currently available or that could be secured by the fisheries agency. This also includes the availability and qualification of scientists, administrative and support staff, data collection officers, enforcement officers, etc. The intent of subjective questions such as these is to allow users to think through characteristics of their fishery that will influence the feasibility of implementing certain management options. See the subjective questions section in the FishPath Tool User Guide	Low Low-moderate Moderate Moderate-high High	X	X	X
Is the species difficult to detect due to being camouflaged or hidden?	If the species is difficult to detect, then the representativeness of sampling (e.g. by dive or underwater camera surveys) or targeted fishing (e.g. in hand collection fisheries) may be compromised	No Yes	X		
Is the fishery multispecies, either in terms of target or bycatch species?		No Yes	X	X	X
Are the markets, home ports, or landing sites numerous or spatially dispersed?	Collection of representative data and enforcement can be more difficult when home ports, landing sites, or markets are numerous or geographically dispersed	No Yes	X		X
Is the life history of the species sex-specific?	Life-history characteristics, such as growth rates, maximum sizes (i.e. Linf), age-at-maturity, or natural mortality, may be different between males and females. These values are required inputs to certain assessment options, and interpretation of the assessment results should be made with caution if these parameters are sex-specific. Users should answer 'yes' if these parameters are significantly different between males and females	No Yes		X	X

(Continues)

TABLE 2 (Continued)

Illustrative questions					
Question	**Description**	**Possible answers**	**Data collection**	**Assessment**	**Management measures**
What time series of length composition data exists?	If only aggregated data is available, then the categories, or 'bins', should be quantitative (e.g. 2 cm bins). Qualitative bins (e.g. 'big', 'medium' and 'small') are insufficient for most methods. If the bins are qualitative, then answer 1 This question refers to data from either fishery-dependent or fishery-independent sampling	0: Absent 1: Snapshot (1–2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that are poorly sampled or poorly representative 2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries 3: Moderate to low bias, but high imprecision in time series. Moderate flaws that do not significantly bias time series data representativeness but do create significant imprecision. Examples: 'partial' time series that reflect only most major years of removals and major fleets/metiers; sampling that covers most of the temporal-spatial extent of the fishery and generally reported at the species level (low bias), but sample sizes may be low (high imprecision) 4: Bias and imprecision are minimal. There are few, if any, flaws in time series data representativeness and sampling, and bias and imprecision are not a major concern. Examples: time series that cover recognised major removal histories, fleets and areas, as well as high resolution in species reporting and sufficient sample sizes to minimise imprecision		X	

Note: Questions may appear in one or more of the 3 components of (1) data collection, (2) assessment and (3) management measures (as indicated by X's). Each question also contains a description to help users better understand the question, and a set of answer options. The full list of questions can be found in supplementary information S3 (FishPath Questions - Sept 20 '22 - Google Sheets).

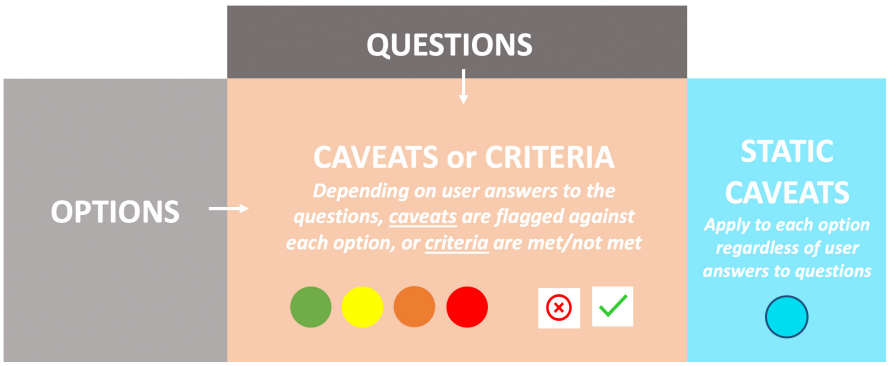

FIGURE 5 Simplified conceptual framework of the online FishPath Tool that demonstrates how user responses to the FishPath Tool questions are linked to options, along with criteria and caveats. Unique user answers 'trigger' criteria and caveats against each option. The full content matrices demonstrating these linkages can be found in supplementary information S4 (FishPath Content Matrices - Sept 20 '22 - Google Sheets).

Example Questions

Example Options	Is the species sedentary, sessile, or have limited adult movement?	If species are captured, handled, and released, do they experience significant levels of mortality?	Static Caveats
Catch Limit: Set by Area	**If yes:** Area-specific catch limits are suited to sedentary or sessile species.	**If yes**: High probability of fishing-induced mortality associated with discarding	If limit perceived too low, might induce illegal fishing
Gear Restrictions: By Selectivity		**If yes**: Selective gear may be helpful in avoiding capture of individuals likely to be discarded	Gear management does not directly control fishing mortality
Minimum Legal Size	**If yes:** Size limits may have to consider what life history stage is being targeted.	**If yes**: Any fish captured has high likelihood of mortality	Size limits do not directly control fishing mortality

Paraphrased caveats

FIGURE 6 Example question and option linkages (2 questions, 3 options) in the online FishPath Tool from the management measures component. Upon answering a question, a user's answers trigger caveats (colour scale strength, centre) against all of the possible options in the management measures component. The full management measure content matrices, and other sections of the data collection and assessment component, can be found in supplementary information S4 (FishPath Content Matrices - Sept 20 '22 - Google Sheets).

traceability facilitates the ready evaluation of alternative responses when dealing with subjective questions.

Upon completion of the questionnaire, the FishPath results are presented under each of the three components of a harvest strategy separately: (1) Data Collection, (2) Stock Assessment and (3) Management Measures. The Tool does not specify the form of decision or harvest control rules, rather, it identifies the types of management measures that may be viable (e.g. a total allowable catch, as opposed to a control rule that adjusts a TAC according to a performance indicator relative to a reference point). Nor does it explicitly or automatically link the three harvest strategy components: this is typically undertaken as part of the FishPath Process (see below). However, the user can identify how current data limitations that preclude certain assessment options may be overcome based on the options identified by the Data Collection component. Also, the output metric of each assessment option is

A. Excerpt from Interactive Results Table

Notes	Criteria	Caveats	Input-Based Category	Assessment 'Tier'	Option
	✗ 1 5 2 3	1 2 2	Population Dynamics Model	Extended Simple Stock Synthesis (XSSS)	
	✓ 2	1 2 3 1 5	Catch Only	Depletion analysis	

B. Description of criteria and caveat symbols

Symbol	Description
✓ ✗	Indicate by green check marks or red crosses, respectively, that the fishery meets the minimum criteria. This applies to the Data Collection and Assessment sections only.
1 5 2 3	For the Assessment section only, "traffic light" colored (red, orange, yellow, green) guidance by relevant criteria encourage users to explicitly consider the possible uncertainty associated with the quality of their fishery's information (where green is the optimal quality or quantity of information). Numbers represent the number of criteria with the associated colored tagging. Red indicates the strongest warning and black indicates unmet criteria.
1 2 3 1 5	A suite of "traffic light" colored caveats related to each option, which are intended to provide cautionary warnings. Caveat strength is implied by colors (red, orange, yellow) or indicates a positive attribute (green) for the option. Static caveats, highlighted in blue, provide additional information, assumptions, limitations, or warnings associated with the option that apply independently of fishery circumstances or user responses to the questionnaire.

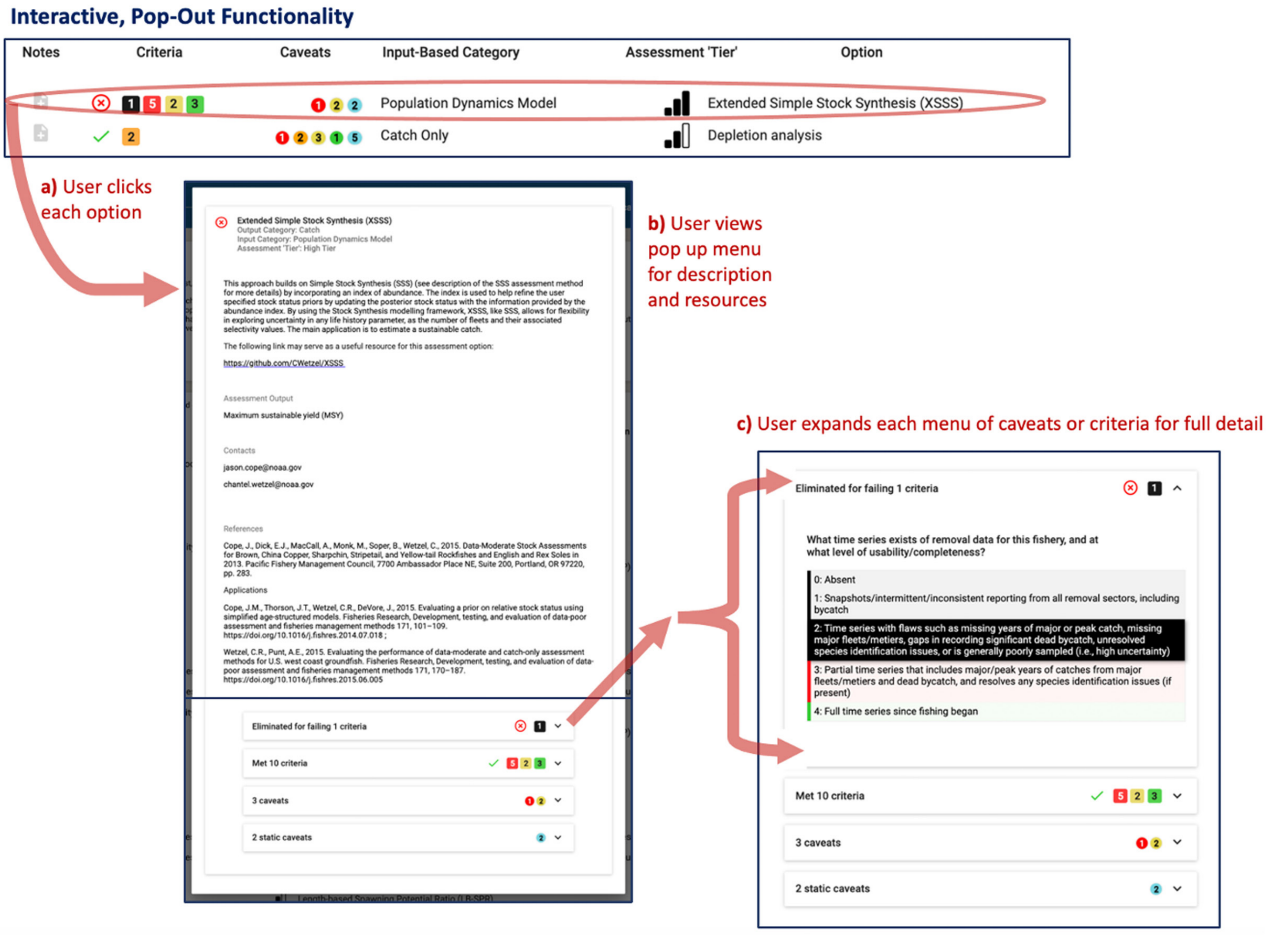

FIGURE 7 An example of the FishPath Tool results in table presentation (A) and explanation of criteria and caveat symbols (B). A red cross indicates that the fishery did not meet the minimum criteria for that option. Each option is a live link that can be expanded to show a detailed explanation of the option itself and of each criterion and caveat invoked by the user response. When presented with the full list of options in the FishPath Tool results section, tool users may: (a) click on each option; then, (b) view a pop-up menu, which contains a description of the option and resources; and (c) explore expandable lists of the relevant criteria and caveats for each option when applied to the unique fishery context, by clicking on each.

explicitly described, such that users can link these to viable management measures and thus have a basis on which to formulate a harvest control rule.

Currently, the living, but ever-growing FishPath Tool contains 50 Data Collection options, 49 Assessment options and 40 types of Management Measures. The FishPath core team regularly reviews the literature to ensure the available (particularly, assessment) options are as exhaustive and up-to-date as possible. The results are displayed in interactive tables that summarise, for each component, the caveats invoked, the criteria met and (for the Assessment component) the uncertainty in data associated with each criterion (Figure 7). Each option within the results table is a link that can be expanded to reveal the description of each option and enable exploration of each criterion and invoked caveat (Figure 7).

The FishPath Tool output is explicit about the requirements and assumptions for each specific option under each harvest strategy component. Such detailed reporting of option matching, and the format of the output (i.e. match or mismatch, criteria and caveats), goes beyond a binary 'included/excluded' outcome by encouraging users to consider the caveats and uncertainties associated with any Data Collection, Assessment or Management Measure option, and weight these in the context of their fishery, rather than prescribing any one option. Functional features such as note taking provide means to capture reasoning and provide important background details.

The FishPath Tool offers specific, stepwise advice to the user to further refine the results table to a shorter, more workable subset of options. For each of the three sets of components, the user is taken through a series of up to 15 considerations or steps embracing retention of options, identification of top options and ranking of top options (these are detailed in Supplementary Information S5). This is a manual process: the Tool does not auto-filter the short (often, long) list of possible options to recommend a single 'front-runner' harvest strategy component option. Results narrowing relies on users paying due attention to the detail within the results, forcing them to confront caveats and strengths, and to return, if necessary, to the questions. This adheres to the guiding principle of allowing users to make decisions from the information FishPath provides, rather than prescribing one answer, while providing a strong rationale as to why certain options are more appropriate than others.

Throughout this result-narrowing process, interactive features include the ability to store notes on every decision point in the process (including answer justifications) and undertake customised ranking to prioritise options, and automated report generation to capture the notes and results tailored to a particular set of stakeholders. The aim is to achieve a short list of options that may then be further specified by stakeholders for inclusion in a harvest strategy (Figure 1).

Results from applying the FishPath Tool across all components of the harvest strategy highlight the best-matching of options and current conditions. Equally important is the highlighting of data gaps and the inherent potential of yet to be realised options produced by conducting 'what if' scenario analyses to support adaptive improvement in all aspects of the harvest strategy. This facilitates policy scoping whereby users can detect constraints and issues linked to current circumstances and understand how alternative approaches could be realised.

Whether applied within a facilitated process or by individuals, the FishPath Tool allows users to fully scope and explore viable options for the three harvest strategy components, in the context of their current or hypothetical circumstances. At the same time, the Tool is a large, collated resource of information that can be flexibly applied in a number of alternative ways to suit different user needs: (i) as a reference or educational tool, against which to check information criteria and caveats for a certain type of assessment, data collection or management measure approach; (ii) to explore viable options for one component only (e.g. the assessment component), either in the presence or absence of existing management arrangements; (iii) to corroborate that the existing harvest strategy, or its components, is best suited to the fishery and to identify issues previously not considered; (iv) to focus stakeholder discussions and flush out key limiting factors to successful fisheries management; or (v) as an individual at a desktop or within small focus groups to rapidly characterise a fishery.

For the FishPath Tool to have the broadest possible uptake impact, this accessibility and flexibility are paramount. Expecting users to only apply the Tool in a facilitated manner limits the opportunities to access the Tool's extensive resources and applicability. That stated, the FishPath Tool does not encompass the tactical design of a fully articulated harvest strategy. Rather, it positions the user to assemble the harvest strategy by providing the details of the viable component options. To formally undertake this next step, we have developed an expert-facilitated process (the 'FishPath Process'), described below, that leverages expert knowledge and support tools. In the absence of a facilitated process, users will need to identify experts or additional support tools on their own in order to use FishPath outputs to develop a fully articulated harvest strategy.

3.2 | The FishPath Process and Network

The FishPath Process is an expanded, facilitated multi-stakeholder, participatory ('bottom-up') engagement process that guides participants through the development of a harvest strategy (Figure 8). In a DCL fishery context, decision-support tools are tremendously valuable when applied as part of a tailored process that integrates training and capacity building (Crosman et al., 2020).

The potential of the Tool is optimised when applied within a facilitated group setting. In this context, the questionnaire can incorporate input from multiple stakeholders and experts, providing a standardised platform to encourage issues-based discussion and a vehicle to address bottlenecks, assumptions and challenges. Eliciting a variety of expert opinions weaves multiple voices into management objectives and binds more people in the fisheries management process. In the event a question cannot be answered by those in attendance, a bookmarking feature allows for certain questions to be flagged for further review once other experts knowledgeable about

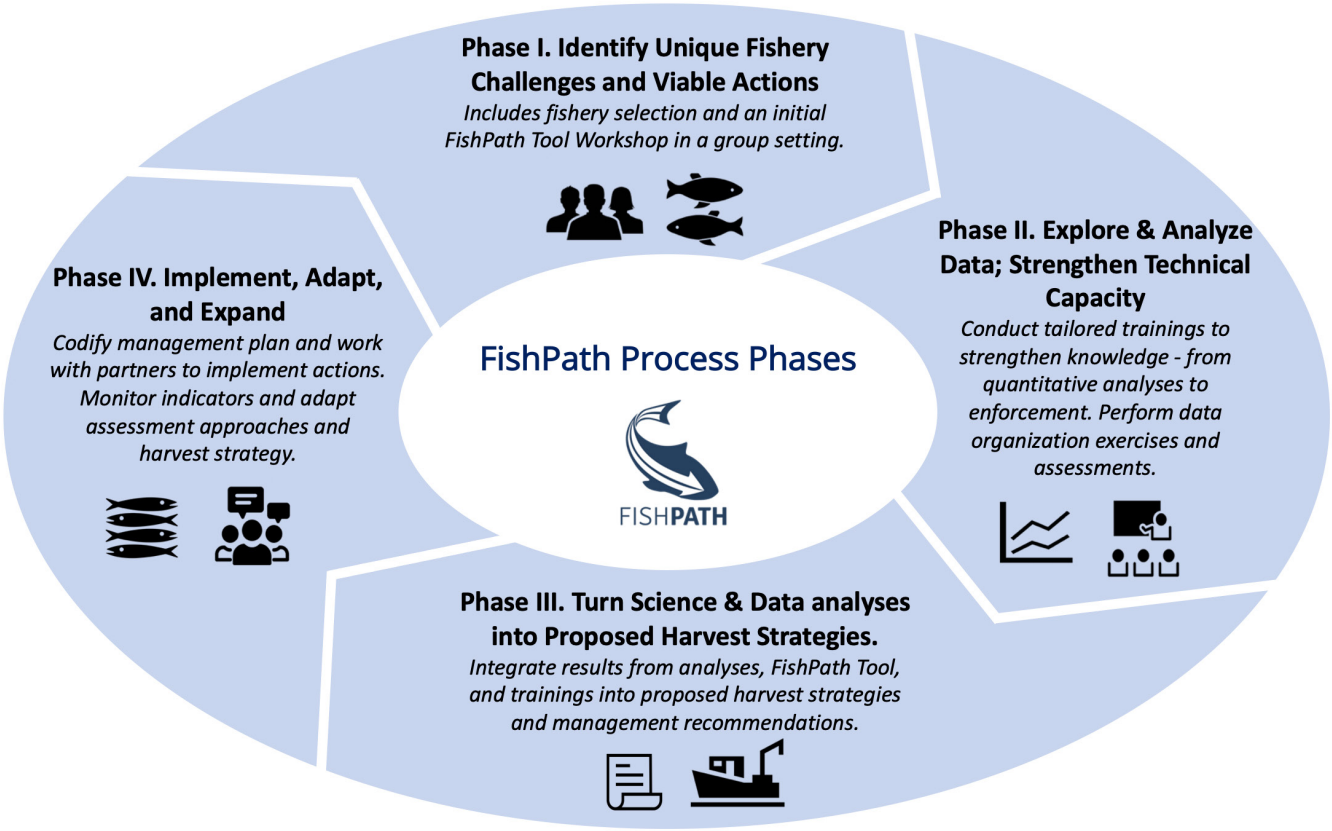

FIGURE 8 The four key phases of the FishPath Process.

those questions have been contacted, expanding the expertise used in answering the questions.

The FishPath Process and Tool synergistically combine to ensure a documented, transparent, replicable and efficient process. While the Tool identifies viable harvest strategy component options, the Process provides the guidance to link and flesh these out to a fully articulated harvest strategy. Harvest strategy formulation is undertaken as part of the FishPath Process using a template into which options identified by FishPath can be imported. Again, the active participation of users is stressed at this stage.

The FishPath Process is a broader, ongoing engagement consisting of four key phases: (i) articulating management objectives, identifying unique fishery challenges and facilitating the articulation of a shortlist of viable harvest strategy component options identified using the FishPath Tool; (ii) tailored capacity building; typically, technical training in data management and analysis, application of stock assessment methods and the development of formal harvest control rules that use the assessment outcomes to adjust the management measures; (iii) fully articulating and evaluating alternative harvest strategies (the latter either qualitatively, via retrospective analysis or an expert-driven Delphi approach, or quantitatively, via closed-loop simulations (e.g. management strategy/procedure evaluation) (Carruthers et al., 2016; Punt et al., 2016)), including developing an action plan for monitoring and management and; (iv) assisting with implementation of the harvest strategy, including adaptive management so the harvest strategy can evolve or be updated (e.g. at periods of regular formal review) (e.g. when precautionary triggers are invoked that obligate a more defensible assessment before any further exploitation can be warranted—see, for example Dowling et al., 2008) by confronting and addressing data gaps and ongoing management challenges. This process can then be replicated across other fisheries or species (Figure 6).

The FishPath Tool stops short of fleshing out and linking the harvest strategy components and also does not include simulation tools for management strategy evaluations (MSE). As such, the FishPath Process relies on other tactical design tools and resources to define and evaluate harvest strategies.

For example,

- In terms of support around undertaking the vast range of available data-limited stock assessments, Dichmont et al.'s (2021) Stock Assessment Toolbox provides links to many of the freely-available packages that can be used by users to conduct fish and invertebrate stock assessments. It summarises those methods, and details installation and usage guidelines for selected packages. This Toolbox is provided as a link in the FishPath Tool under specific method options as one source to find package information. A leading 'umbrella' package is the Stock Synthesis Data-Limited Tool (SS-DL; https://github.com/shcaba/SS-DL-tool). SS-DL implements a spectrum of stock assessment approaches, from data-limited to data-rich, using the powerful Stock Synthesis

modelling framework (Methot & Wetzel, 2013), and presents them in a freely-available user-friendly application.

- FishPath can guide both tactical and strategic management decisions (the former via specification of viable harvest strategy component options, the latter via eliciting key details of a fishery's unique characteristics and constraints) (Figure 7), all of which can then, after thoughtful construction and specification, be applied and tested in more formal and quantitative ways (e.g. Carruthers et al., 2016; Carruthers & Hordyk, 2018; Harford et al., 2016). Formal MSE may be undertaken using Carruthers et al.'s data-limited methods toolkit (https://www.datalimitedtoolkit.org/; https://cran.r-project.org/web/packages/DLMtool/DLMtool.pdf) (Carruthers & Hordyk, 2018) and Methods Evaluation and Risk Assessment (MERA) app (https://www.merafish.org/). These tools enable closed-loop simulation testing of alternative candidate management procedures, where these are identified according to a fishery's data and life-history characteristics, also elicited by a questionnaire. A simulation testing approach helps scientists and managers (1) identify the most effective management procedures given the uncertainties associated with data-limited fisheries, (2) compute stock projections to quantify risks and elaborate explicit management guidance and (3) prioritize future data collection programs. The FLR toolset (https://flr-project.org/) is another R-based library package that has been used to test data-limited management procedures (Kell et al., 2007).

Other complementary resources that can assist in harvest strategy development include Harford et al.'s (2021) guidance on developing multi-indicator harvest strategy frameworks and the Environmental Defense Fund's online Framework for Integrated Stock and Habitat Evaluation (FISHE) tool (http://fishe.edf.org/). FISHE provides a step-by-step process and detailed written guidance for providing scientific guidance for the management of data-limited fisheries and provides an explicit link to the FishPath Tool. FISHE also provides a Guidance Document for choosing performance indicators, identifying reference points and defining harvest control rules in the form of multi-indicator decision tables.

While direct and ongoing engagements are resource-intensive, the FishPath Process makes the engagement process efficient by recognising pre-agreed-upon management objectives and directly addressing all foreseen challenges using a structured, replicable and impartial approach. Experience applying FishPath around the world (https://www.fishpath.org/case-studies) suggests as little as two days of a FishPath engagement leads to tangible results and forward progress that can save weeks to months of future meetings of little progress while setting a clear path towards achieving long-term self-sufficiency among scientists and managers and targeting specific capacity-building training. Such investment in forward progress should also be compared with the cost of giving in to management paralysis and forgoing a harvest strategy (Dowling et al., 2019).

In support of the Tool and the Process, The FishPath Network, launched in early 2020, is a global network of fishery practitioners that are trained and experienced in the implementation of the FishPath Process and Tool (https://www.fishpath.org/fishpath-network). The quality of the FishPath Process will, to an extent, depend on the experience and expertise of the facilitator, and the network serves as a formal training platform for FishPath facilitators. FishPath Network members engage with and empower fishery stakeholders to guide them through the FishPath Process and strategic use of the Tool. As a community of practice, the FishPath Network serves as a global resource for those using the Tool strategically and requiring customised training or support. It also leverages local knowledge as the growing network represents members from all over the world.

4 | CASE STUDIES ILLUSTRATING THE TOOL AND THE NATURE OF THE FACILITATED FISHPATH PROCESS

To address challenges related to the commercial finfish fishery of *Graus nigra* (known locally as *'vieja negra'*), and the broader coastal finfish assemblage, the FishPath Tool was applied in a series of facilitated workshops during 2019–2022, in partnership with the *Instituto de Fomento Pesquero* (IFOP), and the government agencies managing fisheries (*Subsecretaría de Pesca y Acuicultura* (SUBPESCA) and *Servicio Nacional de Pesca y Acuicultura* (SERNAPESCA)), as well as academics, local NGOs and fishers. Answering the FishPath Tool questionnaire in a facilitated group setting provided a diverse set of stakeholders with a structured mechanism to discuss and identify assessment and management options for coastal finfish. A significant outcome of the FishPath Process in Chile has been the identification of critical knowledge gaps that need to be addressed to move forward in the management of the coastal finfish assemblage. To address these needs, in addition to applying the FishPath Process with stakeholders, the FishPath team enhanced the Process with (i) an extensive data compilation and review exercise; (ii) a legal analysis to ensure that the management measure recommendations for these species (which are not recognised as species-specific fisheries in Chilean fisheries law) could be accommodated into the existing legal framework and (iii) the design of studies to improve understanding of movement patterns and home ranges via fish tagging and visual recapture in order to better inform spatial management measures identified in the FishPath Tool list of top options. A public-facing booklet of recreational fishery management recommendations was produced. A draft resolution was proposed in 2022 for the number of individual species captured per fisher per day (bag limits) for recreationally captured finfish, but this still needs to be circulated and reviewed in a citizen review process (SUBPESCA, 2022). Currently, the team and partners continue to advance the improved management of the *vieja negra* fishery and 13 additional species by working on defining the strength of the measures for the commercial sector, with the aim of revised fishery policy at national and regional levels. In addition, FishPath has been applied to other fisheries in Chile, such as the razor clam fishery in the Bahia de Corral (navajuela).

In the Australian state of New South Wales (NSW), FishPath is used to directly support harvest strategy development. Many NSW fisheries comprise multiple species, gear types and fishing sectors (e.g. recreational and commercial). They are also of relatively low financial value and have limited data to support fully integrated model-based assessments and associated management arrangements. Collectively, these aspects present significant challenges to the development of harvest strategies. The restrictions imposed by the COVID-19 pandemic prohibited the use of the FishPath Tool in a live facilitated workshop setting with full stakeholder representation. Instead, the FishPath Tool was applied across multiple online workshops with a focussed group of fishery scientists and managers from the NSW Department of Primary Industries. Typically, three sets of online workshops were undertaken per species or fishery: the first to complete the FishPath questionnaire, the second to review and narrow the list of available options and the third to begin to flesh out the details of a harvest strategy linking the three components. A key feature of the Process in this context was the identification of options that could form a 'modified status quo' harvest strategy (i.e. one that could be implemented with minimal, or small, cost-effective, easily-implemented changes to the existing management arrangements), as distinct from options that could form an 'aspirational' or 'enhanced' harvest strategy—one that could be implemented given additional data collection, resourcing and stakeholder buy-in. For each set of options, the components were linked and a fully articulated harvest strategy was drafted as a 'straw man' to be presented, along with a condensed summary of the FishPath Tool output, for consideration by, and input from, the broader formal fishery-specific Working Groups. The ability to demonstrate a transparent and replicable process was a key advantage, allowing the pathway and justification for any decision to be demonstrated to stakeholders who were not directly involved in answering the questionnaire. This transparency has provided both accountability and flexibility, in that question responses and option selection could be readily revisited.

These are two of many examples of FishPath applications across the globe. Others can be found at https://www.fishpath.org/case-studies.

5 | DISCUSSION

The FishPath Tool and Process were designed to support practitioners through the initial scoping stages of the components of a harvest strategy and begin the process of articulating a harvest strategy. From a user point of view, FishPath's advantage lies in its extensive content, accessible interface, efficiency and transparency, and its ability to bring stakeholders along for the journey of imputing and translating their knowledge to appropriate options for harvest strategy components. The Tool has been subjected to rigorous, formal peer reviews by an international panel of 12 experts overseen by the Nature Conservancy, and by a panel of recreational fishery experts from New South Wales, Australia. Both panels comprehensively interrogated the software and provided confidential written reports. A formal evaluation of FishPath's effect on stakeholder buy-in showed that its use increased stakeholder perceptions of the need for science-based management and how their input can contribute to more effective management measures (Crosman et al., 2020). We continue to grow and evolve the Tool in response to user feedback, the emergence of new assessment methods, and newly encountered circumstances within case studies. Future additional modules, including fishery enforcement, and specification of harvest control rules, offer potential areas of Tool expansion.

Often, the lists of appropriate harvest strategy component options presented to stakeholders by the FishPath Tool are long. The process of narrowing these options further can therefore be daunting. One potential area for future research that would improve the tool would be to interrogate the accumulated database of case studies, to attempt to identify emergent principles and, potentially, 'archetype' fisheries, wherein sets of common questionnaire responses could be linked to final shortlisted options. The Tool could then use these learnings to 'auto-filter' the longlist of possible options to a more manageable subset.

While intending to be generic and all-embracing, FishPath is currently commercial fishery-centric, although the Tool has successfully been applied to community-based, subsistence fisheries (e.g. Hawai'i; https://www.fishpath.org/case-studies) and recreational fisheries. Given the variety of fisheries in the world, we are always seeking refinements to ensure they are as representative of this diversity as possible.

In terms of the broader FishPath Process, there are obvious costs associated with long-term fishery engagements, and there are a limited number of trained FishPath facilitators. While the FishPath Network has the explicit aim of growing the pool of qualified facilitators, resourcing remains an inherent challenge when engaging in a full-blown multi-year FishPath Process. That stated, the FishPath Tool, and the standardised, explicit approach provided by the Process, confer an efficient and thereby cost-effective means to break the cycle of management paralysis. With an increasing number of FishPath engagements around the world, there are also opportunities to test alternative approaches to accelerate the use and application of FishPath as it continues to evolve. Resources have long been channelled to capacity building and the provision of 'top-down' expert-prescribed advice; FishPath provides a 'bottom-up' engagement process to optimise the return on this investment of resources. And outside the formal FishPath Process, non-facilitated and repeated use of the Tool in the variety of potential ways outlined in this paper builds familiarity with options that can lead to important insights and solutions for any given situation.

6 | CONCLUSION: FishPath ADDRESSES THE CONDITIONS THAT THWART SCIENCE-BASED FISHERIES MANAGEMENT

Globally, DCL fisheries require stakeholder engagement combined with tailored capacity building during the process of harvest strategy design. The FishPath Process and Network enhance the application

of the improved FishPath Tool in confronting the often-daunting conditions that lead to paralysis in the development of DCL harvest strategies, or to generic solutions that may be poor fits to specific conditions, and that ultimately thwart science-based fisheries management. FishPath breaks the paralysis cycle to set DCL fisheries on the road to sustainability, by addressing those initial conditions and identifying context-appropriate pathways forward:

1. *Resource limitations*: The FishPath Tool provides a pragmatic means to provide customised guidance that leverages the latest fisheries theory combined with local conditions. In essence, it provides information to stakeholders as to what they can effectively do with what they currently have available. Additionally, by identifying the specific criteria or caveats that preclude particular options, the FishPath Tool enables stakeholders to readily identify possible pathways to improving their data collection protocols or assessment approaches. Explicitly identifying gaps in data and capacity is a key aspect of adaptive management (Parma et al., 1998).

Encouraging a 'bottom-up' approach that empowers stakeholders can be efficient, cost-effective and ultimately lead to broadly supported outcomes (Ahmed et al., 1997; Ayers & Kittinger, 2014; McCay & Jentoft, 1996; Rivera et al., 2014; Smith et al., 1999). The FishPath Process enables resources to be invested constructively (e.g. using their voices to articulate the details of an identified harvest strategy, as opposed to spending the majority of time attempting to identify viable options) and in a targeted manner. When resources such as time and money are limited, effective and concentrated effort that yields progress is vital and scalable.

When applied in a group setting, the constraints or limitations highlighted by the FishPath Tool can identify specific areas where capacity building is most needed, thus targeting the most effective training and outreach programs and engaging those that will participate in the training from the beginning. The Tool's questionnaire elicits critical context-specific details of the data, the fishery, the parameters and important human dimensions that can drive harvest strategy specification. Ultimately, these details can help to directly inform the specification of stock assessment models (tactical) and closed-looped simulations (e.g. management strategy evaluations (strategic)).

2. *Associated characteristics and 'uniqueness' of data- and capacity-limited fisheries*: By eliciting the unique characteristics of a fishery through its online diagnostic questionnaire, the FishPath Tool identifies context-specific positive attributes, cautions and considerations for each available option in a harvest strategy. Thus, uniqueness, considered a barrier before, becomes a key contribution to finding appropriate solutions.

FishPath allows stakeholders to be engaged from the point of harvest strategy inception and to understand how choices are made, as advocated by Stratoudakis et al. (2014). The FishPath Process seeks the inclusion of a range of stakeholders, from the process of identifying harvest strategy options through the FishPath Tool, to the selection and articulation of the harvest strategy(ies) of choice. This emphasis on adequate representation gives the best understanding of a fishery, ensuring that agreed-upon harvest strategy components are understood by and acceptable to stakeholders. The transparency of the FishPath Process and Tool enables stakeholders to clearly see how their responses influence the results. FishPath thereby becomes a communication tool in addition to finding science-based solutions to management objectives. Having helped to shape the harvest strategy, stakeholders are more likely to accept the resulting management measures (Ostrom, 2007).

By providing a vehicle for local knowledge, the FishPath Tool and Process also keep discussions focussed, decrease the chance of tangential issues derailing progress and increase the chance of avoiding debilitating setbacks from lack of procedural understanding (e.g. through misapplication of 'off-the-shelf' or generic expert prescriptions). By providing explicit advice as to why certain options are not currently feasible, the Tool is flexible in that users are encouraged to take the journey to think about future possibilities that can lead to more coordinated data collection and effective management efforts. It also is a repository of both options and answers, tracking decision-making and facilitating rapid synchronisation between meetings.

3. *The concept of harvest strategies is unfamiliar, and the universe of options is hard to navigate*: While each fishery is unique, the FishPath Tool provides a standardised, structured platform and a user-friendly interface to navigate among the universe of options. Via a user-friendly, 'bottom-up' engagement process, FishPath embraces a feedback-based, practical and comprehensive approach, which empowers local expertise and provides a vehicle for operationalising their knowledge. The presentation of information and options in a single, transparent framework avoids the narrow scope associated with generic, or prescribed, management approaches, and confers assurance that the harvest strategy approaches selected are defensibly appropriate.

Having identified viable options and the specific criteria and caveats invoked against each, the FishPath Tool provides a repository of information with detailed descriptions against each option, references and case study applications and, where applicable, identifies tools and contacts to support specific analyses. The FishPath Process provides expert facilitation and scientific support, so that the Tool and its detailed contents are most efficiently applied, while still reflecting the management objectives based on local voices and needs. As the FishPath Network grows, experiences will build and merge as struggles and successes lead to a larger commons from which to draw solutions.

FishPath provides a standardised process for engagement that is driven by user responses as opposed to 'top-down' expertise. As such it is unbiased by the knowledge or preferences of local or

hired experts. The development of harvest strategies has often otherwise occurred on an ad hoc basis, with the natural limitation of being constrained by what is familiar (Figure 2), rather than having an accessible and comprehensive list of possibilities. FishPath allows the selection process to be unbiased by providing a formal and replicable structured process that informs the user as to the advantages and disadvantages of each option.

FishPath provides an important space to pause and collect thoughts between harvest strategy design and deployment in order to capture, and objectively consider, localised specifications (e.g. avoiding methods you technically can apply (all criteria met), but should not (weakly met caveats)), rather than automating the whole process (e.g. McDonald et al., 2018). This addresses the philosophy and the vision that DCL fisheries require an individually tailored approach to fisheries management that is identified through an engaged process. If knowledge is power, the FishPath approach embraces the philosophy that organised knowledge is power realised.

To date, FishPath has been applied to an ever-growing range of fisheries around the world (as can be seen at https://www.fishpath.org/case-studies), both in developed and developing nations, in tropical and temperate locales, spanning a range of species (both invertebrate and vertebrates) with diverse life histories, and various fishery and management contexts (including those employing more static management measures, such as seasonal closures, that are less responsive to dynamic conditions) (https://www.fishpath.org/case-studies) (Fitzgerald et al., 2018). As more fisheries engage with the FishPath Tool, the FishPath database will continually expand and serve as a growing repository of fishery case studies. We can draw on this database for comparative meta-analysis, from which broader principles may emerge.

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DATA AVAILABILITY STATEMENT

No data were utilised in this study.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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