Turks and Caicos Islands

Field Report

2003

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1.0 Introduction

The Participatory Fisheries Stock Assessment project R7947 (PFSA) forms part of the Marine Resource Assessment Group's (MRAG) Fisheries Management Science Programme FMSP) and is funded by the Department for International Development (DfID). The PFSA project aims to provide information to fisheries managers in the form of a scientific advisory based on a participatory interview technique, existing and archival data, and data that can be collected rapidly in the field. The method is flexible and enables advisories to be produced for a variety of fisheries.

The PFSA technique was field tested in the Turks and Caicos Islands (TCI) in July 2003 in partnership with the Department of the Environment and Coastal Resources (DECR), as part of the on-going development of the method. Research focused on the continued field testing of the interview technique, and the incorporation of the extensive time-series catch and effort data collected by the DECR for the islands Queen conch (*Strombus gigas*) fishery.

Objectives:

- Continue the development of the PFSA interview technique;
- Conduct interviews in TCI conch fisheries;
- Produce interview based data to be used as a prior within the PFSA technique;
- Use existing catch-effort time series data to test validity of the PFSA method;
- Produce an assessment of the conch fishery incorporating participatory information and existing catch-effort data;
- Provide an updated scientific advisory to the Department of Environmental and Coastal Resources (DECR) based on the PFSA technique.

This report provides a summary of the fieldwork undertaken and the stock assessment produced for the conch fishery using the PFSA software in the form of a scientific advisory.

2.0 Study Area

The Turks and Caicos Islands (TCI) are a small group of low-lying islands at the south-eastern end of the Bahamas platform and to the north of Hispaniola. Comprised of 40 low-lying islands and keys the TCI are located on three distinct platforms; the Caicos, the Turks and the Mouchoir banks. Six of the islands are inhabited including Grand Turk and Salt Cay located on the Turks Bank and South, Middle and North Caicos and Providenciales located on the Caicos Bank (figure 1). The total population comprises approximately 20,000 residents (table 1). These islands comprise an area of 370 km^2 and a number of smaller islands and cays add an additional 122 km^2 to the total land mass (Halls *et al,* 1999).

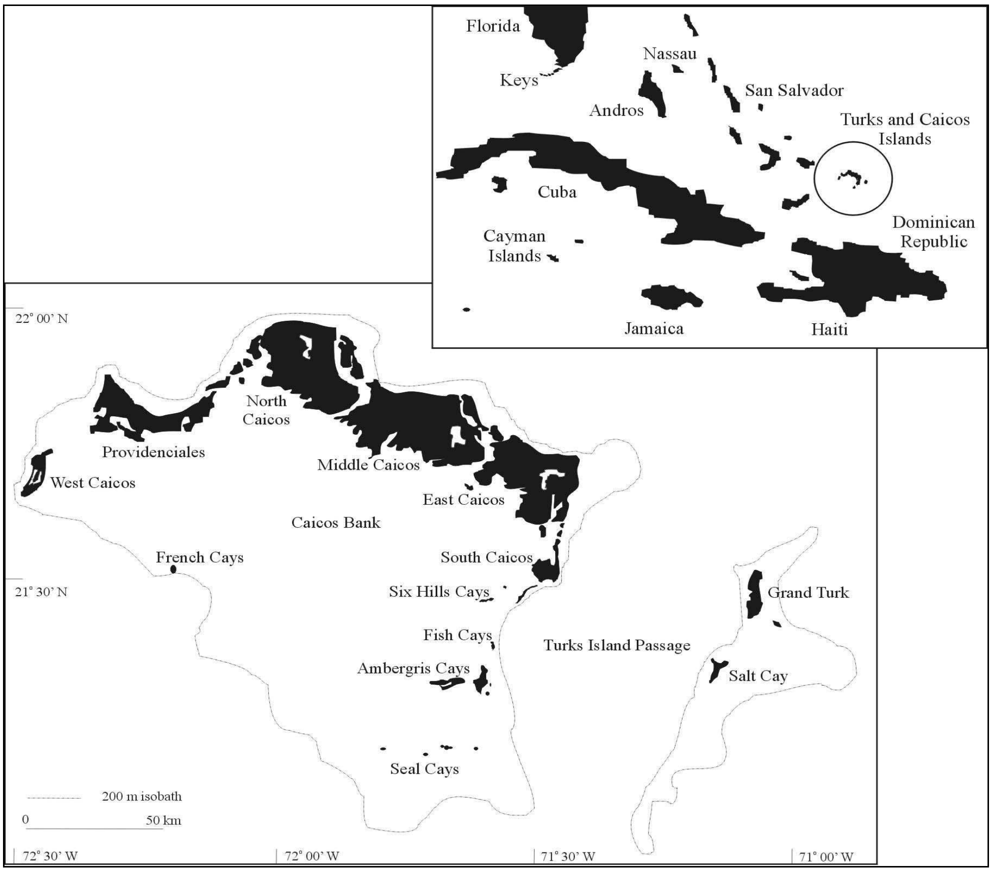

Figure 1. Location of the Turks and Caicos Islands in the Caribbean region highlighting the fishing banks (Caicos and Turks banks) important for commercial fishing of queen conch (*Strombus gigas*). This project focused on locations in South Caicos and Providenciales. (Map from Clerveaux, 2003),

Table 1. Population size and density in the Turks and Caicos Islands. Source: Statistical Year Book (1995), Cameron (1998), and Halls *et al* (1999).

Island	Population	Area (miles^{-2})	Population Density (number/mile^{-2})
Grand Turk	2000	7	286
Salt Cay	208	3	69
South Caicos	1198	8	150
East Caicos	-	18	-
Middle Caicos	272	48	6
North Caicos	1275	41	31
Providenciales	>10000	38	263
Uninhabited Cays	-	48	-

2.1 Marine Habitat

Marine habitats in the Turks and Caicos Islands are extensive, covering an area of 6,500 km^2 (table 2). Bathymetry varies from shallow bank areas nearer to the islands averaging 2-6m in depth, increasing towards the seaward edges of the banks where the average depth increases to between 30 and 40 m. These shallow banks are covered with sand, mangrove and turtle grass (*Thalassia testudinum*) which provide habitat for the two major fisheries targets: spiny lobster (*Panulirus argus*) and the queen conch (*Strombus gigas*). Other habitat types also exist on the bank areas but are not as important in terms of conch biomass. These include coral reef areas which are important for finfish production, mangroves which provide important nursery areas and natural coastal defence structures, and extensive areas of open sand (Olsen, 1986).

Table 2. Benthic associations in the Turks and Caicos. (from Olsen, 1986.)

Benthic Type	Caicos Bank (km^2)	Turks Bank (km^2)	Total (km^2)
Sand	3946	139	4085
Mixed Coral/Vegetation	1134	94	1228
Coral	425	83	508
Tidal Flats	296	1	297
Mangroves	235	1	236
Turtle Grass	104	6	110
Total	6140	324	6564

2.2 Fishing Industry

The fishing industry is very important in the TCI, providing local employment and income through subsistence, recreational and commercial fisheries, as well as almost all exports and export revenue. The principle resources of the commercial fisheries, as detailed by historical catch and effort data have been conch and lobster, centred on a well defined commercial processing sector with nearly all products being exported to the USA (Halls *et al,* 1999). The commercial focus of the industry is quite distinct from other Caribbean fisheries which are directed more at supplying local finfish markets (Harrison, 1991). Catches of reef fish (mainly groupers, snappers, grunts and triggerfish) and bonefish were, and still are, important subsistence catches but few exports have been recorded (Ninnes & Medley, 1995). Historical data for the conch fishery is available back until 1904, whilst records for lobster exist to 1938.

The fishing industry (all fisheries) is divided between four islands (South Caicos, Providenciales, Grand Turk and North Caicos). Fishers require a license though there is some un-quantified illegal fishing. Most licensed fishers are found in North and South Caicos (figure 2) where the largest fishing communities are located.

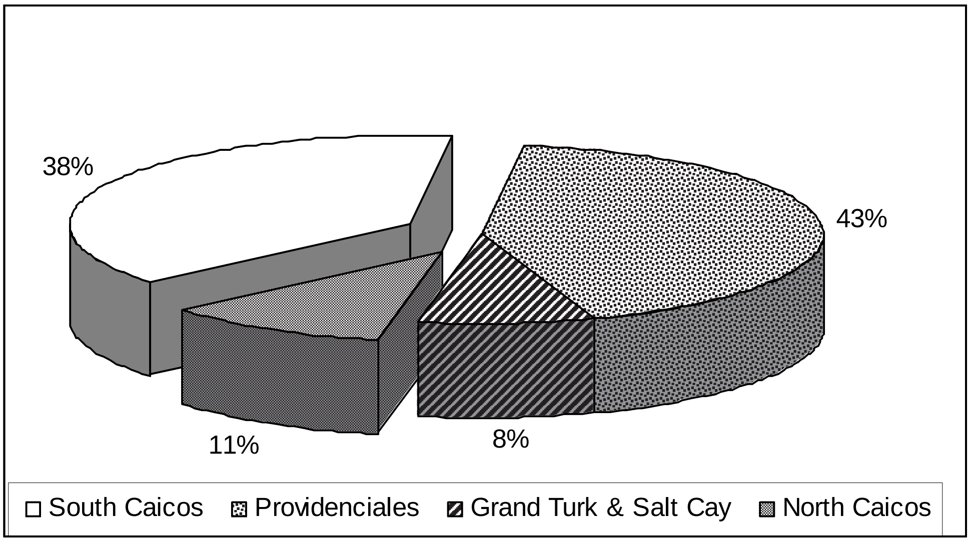

Figure 2. Mean number of registered fishers from all fisheries (1999-2001) categorised by the four main islands (from Clerveaux, 2003).

2.3 Conch Biology

The queen conch (*Strombus gigas*) is a large gastropod which inhabits shallow banks and sea-grass beds. Female conch reach sexual maturity after three years, and reproduction occurs during most of the year (February–November), but most intensively during the warmer months (April-September). Sexual dimorphism exists with the females up to 5% larger shell lengths than males and 20% heavier on reaching maturity. During spawning conch produce up to 400,000 eggs in an area of clear sand on the bank (Ninnes & Medley, 1995). On hatching the larvae immediately enter a pelagic-larval phase for 2-3 weeks. During this period the larvae may become widely dispersed by the prevailing currents, though there is some debate as to how actively the larvae may determine the position of settlement. On reaching a suitable size and encountering a suitable shallow water habitat, the conch larvae go through a settlement phase and are recruited to the bank where they metamorphose into juvenile conch.

Conch spend much of the first year buried under the sand during the day, feeding predominantly at night, and only emerge during the day when their shell is about 3 " long. Shell length in conch increases at about 3 " per year for the next 2 to 2 ½ years. At this point most Conch approach sexual maturity and no further increases in shell length are seen, though there is a distinguishable thickening of the shell lip which has been used to age conch in other studies. Large animals are generally found in deeper water and these may represent semi-protected breeding populations. Little is known about larval transport and recruitment (Ninnes & Medley, 1995; Chaka; & Cochrane, 1996).

2.4 Conch Gears

Traditionally conch were fished from small boats towed to the fishing grounds by larger sloops. Conch were located from the surface using a water glass and then brought to the surface using a hook and length of line from depths of 7m or shallower (Ninnes, 1994). Modern gear comprises a small (5-6 m) fibre-glass boat powered with 60-80 hp outboard engines and conch are collected by free-diving to depths rarely exceeding 15m. The animals are removed from the shell at sea (a process termed ‘knocking’). Some conch fishermen fish single handed but it is more normal for each vessel to have a crew of two or three, including a designated boat driver who also ‘knocks’ the conch, and one or two free divers (Olsen, 1986; Mokoro, 1990; Medley & Ninnes, 1998). SCUBA is not used in the industry in the TCI, reducing the threat of overfishing deeper water stocks.

2.5 Conch Fishery

The conch fishery has operated for almost a century and has traditionally focused on the Caicos bank (Mokoro, 1990). The main locations (figure 1) are (i) east of West Caicos; (ii) southwest of Providenciales; (iii) southwest of South Caicos; and (iv) northeast of Grand Turk (Moran, 1992). Conch catches have fluctuated during this period, with four distinct peaks in the 1910s, 1940s, 1977-1980 and 1984-1987. The first two were the direct result of shift away from the formerly profitable salt trade and increasing demand for conch for both local consumption and export to Haiti. The second two peaks result from further increases in export, particularly to the US with the advent of freezing technology. Catches during these periods exceeded sustainable yields and resulted in declining catches (Ninnes & Medley, 1995). The current Total Allowable Catch (TAC) is set at 1 675 000lbs, worth in excess of 3.2 million US dollars. If the total value of conch associated industries and associated employment are taken into account then this figure would increase several fold (Appledorn, 1997).

2.6 Conch Fishery Regulation

Management of the conch fishery in the TCI takes place at national and international levels. Management has depended upon the extensive time-series of catch-effort data collected through the processing plants, and this data has been used to set quotas for landings and exports. Quotas are granted based on operators' co-operation with the DECR, necessary licensing and procedure being in place before the opening of the season. Individual fishers also require a fishing license before harvesting conch for the plants. The plants regulate their quota by setting daily catch limits for the fishers that supply them and the price of purchase. Each fishing season is followed by a closed season to allow replenishment of the fishing grounds.

The quota system used to manage the fishery is based on predictions made from catch and effort data collected during each season. The conch model is a simple biomass surplus production model based on the Schaefer logistic model. The model is robust and provides catch and stock projections with reasonable accuracy and guides the quota for landings and export (figure 3).

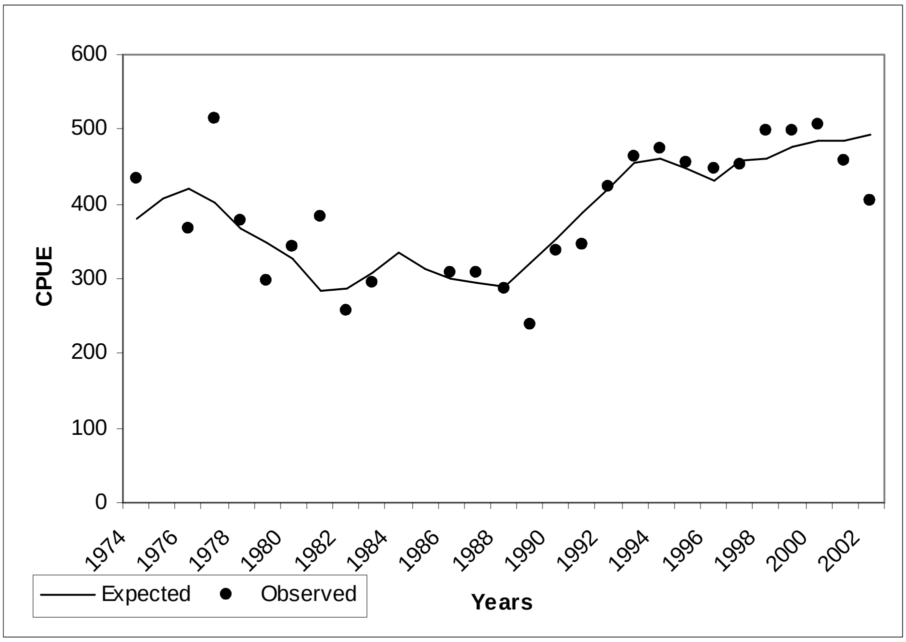

Figure 3. The Schaefer Surplus Yield Model for the conch (*Strombus gigas*) fishery of the Turks and Caicos Islands.

Management at the national level is driven by international agreement under the Convention on International Trade in Endangered Species (CITES). Conch (*Strombus gigas*) is listed on appendix II as a 'species not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilization incompatible with their survival'. As a signatory to CITES, the TCI (through the administration of the DECR) guarantee to provide detailed data on conch exports and issue export permits. Permits are issued on the basis that 'the species in question was legally obtained, and export will not be detrimental to the survival of that species.' Failure to manage conch effectively could result in a withdrawal of export privileges, ending exports and effectively ending the fishery.

3.0 Methodology/Fieldwork Undertaken

The data collected during the PFSA project in TCI was obtained from PFSA interviews conducted with conch fishers by the PFSA consultants and catch/effort data provided by the DECR for inclusion in the analysis. Awareness of the PFSA technique was raised and the findings presented to the DECR and local fishers. An itinery outlining the undertakings of the project is shown in annex 1.

3.1 Interviews

The PFSA interviews were conducted on the Islands of Providenciales and South Caicos between the 3rd and the 21st of July, 2003. Early interviews were conducted with members of the DECR. This provided the PFSA project consultants with an opportunity to trial the technique for both sections of the interview, and particularly the more difficult preference section before entering the field to collect real data. This also allowed for the DECR staff to experience the technique and the information developed, as well as offer advice on how the questions maybe better phrased when dealing with fishers in the TCI.

3.1.1 Providenciales

The project focus was to develop the interview for use in the TCI and inform potential managers and interested parties of the technique and its application to co-management of fisheries. Several meetings were held with the Director of the DECR to discuss the method and the fieldwork to be undertaken during the study, and arrangements made for conducting the data collection. Importantly the DECR also allowed for an introduction to PFSA to be included as part of the Fisherman's Day Workshop series planned for South Caicos. DECR staff also provided introductions to local fishers.

Two consultants with knowledge of the conch fishery, and several part time and recreational conch fishers were interviewed, including those from amongst the DECR staff. Other conch fishers were interviewed at one processing plant. 8 stock assessment sections and the accompanying 8 preference sections were completed.

3.1.2 South Caicos

The conch fishers of South Caicos represented the main focus of the interviews and subsequent dissemination of findings. The PFSA interviews were conducted between the 7th and 17th of July. The technique was introduced through the Fisherman's Day Workshop organised by the DECR to raise local awareness and develop better working relations between fishers and managers, with the view to increasing co-management in the future. The purpose of the PFSA technique was discussed and the importance of the fishers' participation related.

The interviews were conducted with the aid of DECR staff from the South Caicos office who provided introductions to fishermen. A list of fishers was compiled and fishers were approached according to availability. Some fishers were more willing to be involved than others. Interviews were conducted at fisher's houses, on the street, or at Cockburn Harbour after catches had been sorted. During the interview period 38 conch fishers completed the stock assessment interviews, of which 30 also completed the preference section.

4.0 Scientific Advisory: Turks and Caicos Islands Queen Conch (*Strombus gigas*)

4.1 Status of Stock

The assessment indicates there is a 31% probability that the stock is currently overfished: the stock is either already overfished or very close to being in an overfished state. The model indicates the stock has been increasing (i.e. is in a state of recovery) over the last 5 years, with the exception of the last year when catch rates appear to be considerably lower than usual. Recovery rules should be applied when setting controls.

4.2 Management Advice

The quota (Total Allowable Catch) should be lowered to 1.53 million lbs as soon as possible. The analysis indicates that catch rates will increase and fishers should be better off as a result.

The fishery should be classified as recovering rather than fully exploited. Lower quotas will allow the stock to increase, so that higher levels of productivity may be obtained. This can only be verified by maintaining low quotas for a number of years while monitoring continued recovery.

The current quota of 1.675 million lbs catch is higher than the estimated limit control of 1.58 million lbs. The limit controls allows a 10% probability of stock being in an overfished state. More risk-averse policy would lower the limit control further. Management should avoid setting any quota above 1.6 million lbs.

An upper limit on effort as well as a catch quota should be put in placed. Introducing a maximum effort control will reduce risks and allow higher quotas. Such controls decrease the chance that overfishing will be exacerbated as increased effort compensates for poorer catch rates.

4.3 Assessments

Target controls are obtained by maximising the expected preference from applying a control. Preference is based on interviews with the fishers, comparing their current activity and catches with higher and lower values. This indicated that a lower catch allowing catch rates to increase would improve the fishery for the fishermen.

Using only the interviews or only the catch effort model produced different results. The interviews indicated much greater uncertainty, so the limit control had to be set very low to ensure only 10% chance of overfishing. The catch effort model alone indicated much more conservative results than those of the model. In this case a quota around 1.4 million pounds was indicated. This supports the view that, objectively, the current quota is set too high and action should be taken to reduce it.

In the baseline scenario, the preference score includes an importance weight and a discount estimated for each fisher. The importance weight is based on the number of dependents and the proportion of income in the household that depends on this fishery. Removing the importance weight and using the same 10% discount for all fishers raised the target control slightly. This suggests importance and discount have only a small effect.

Table 3. The current control is a catch quota of 1.675 million lbs landed conch weight.

Scenario	Current State Probability	Target Control	Limit Control	Limit State	Limit Probability
Baseline	0.310	1531254.07	1580855.29	50	10
Interviews Only	0.619	1678103.40	791651.55	50	10
Catch and Effort Only	0.530	1384882.67	1432696.19	50	10
Maximum 4500 boat days	0.322	1660047.34	1599492.49	50	10
No importance and 10% discount	0.322	1566629.34	1593478.50	50	10
Price Cost Ratio	0.292	1299976.93	1600540.97	50	10

4.4 Retrospective Analysis

A simple retrospective analysis was undertaken to see whether interviews alone might have improved the management of the fishery had that information been used to set a control in 1974.

The fishery is managed through a quota, so this is the appropriate control. It is worth noting that quota will not necessarily work well. If the state of the fishery was misjudged by fishers so that chronic overfishing is taking place, the quota might be set above the sustainable level even if it is below the maximum sustainable yield. In contrast, would be a safer control as it allows catches to respond to stock size with varying CPUE.

A standard stock assessment using the logistic model fitted to the catch-effort time series indicated the current quota of 1.675 million pounds as too high; it recommended lowering it to 1.6 million pounds landed weight. Using the preference information, the stock assessment based upon both the interview and catch-effort model combined and the catch-effort model alone suggest a lower quota around 1.53 and 1.38 million pounds respectively. A quota of 1.53 million pounds would return the quota to the original recommended level and allow catch rates to increase more rapidly than they are at the moment.

Interviews by themselves are much less accurate (as indicated by the much lower limit control Table 1), but nevertheless recommends a target of 1.68 million pounds, reasonably close to, but above, the other targets.

Table 1 Target and limit controls for the Turks and Caicos Islands Conch fishery based on catch-effort and interview data.

Scenario	Target Control	Limit Control
Interviews and Catch-Effort Model Combined	1531254.07	1580855.29
Interviews Data Only	1678103.40	791651.55
Catch-Effort Model Only	1384882.67	1432696.19

If it is assumed that fishers knew as much in 1974 as they do now, we can use the interview data as representative of what would have been obtained had the interviews been conducted at the beginning of the time series. Hence, the interview-only target quota can be applied at that point to see what might have happened to the fishery had this stock assessment method been applied, assuming that the logistic and maximum likelihood parameter estimates are correct.

The actual total catch over the period 1975-2002 was 45.47 million pounds. Had the 1.68 million pound quota been applied, the results suggest a total catch of 47.00 million pounds. This quota would realise higher catches in the longer term by foregoing higher catches in the late 1970s. A discount rate of around 5% yields approximately the same net present value between the two options.

The real gain, however, would have been the rise in catch rate (Figure 1). The catch-effort model suggests the stock was in an overfished state in 1974 and an enforced quota would have led to stock recovery. In other words, the catch would be met with much less work and costs than is now applied (from 3300 boat days down to 2500 boat days to realise the same catch). It indicates considerable benefits to using just interviews in this case, but would need more testing to make the case as a general statement. In particular, in cases where it turns out the logistic is not the best model, it needs to be shown that interviews may still have value in setting initial targets.

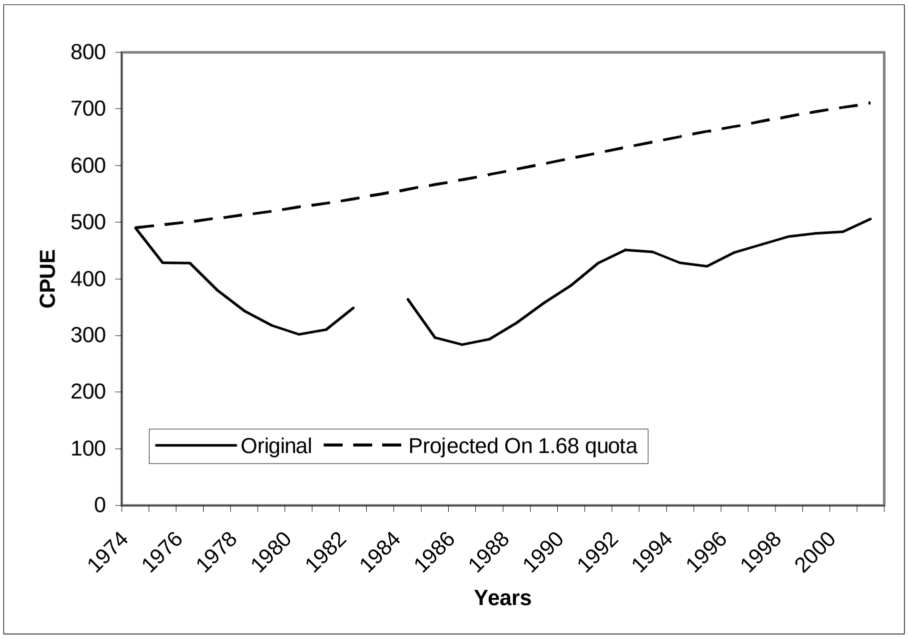

Figure 1 Expected catch per boat day (CPUE) from the fitted logistic model and the projected CPUE with 1.68 million pound quota.

The cost of applying the quota is that, without the depletion in the mid-1980s, less information would now be available on the behaviour of the stock, so that the current stock assessment would be less reliable. This would have to have been addressed through increased research activities.

5.0 Presentations

5.1 South Caicos Fishers

Dissemination of project findings was not the major focus of this stage of the fieldwork, however, the rapid nature of the PFSA technique meant that even within the restricted time frame of the research period useful management information was compiled and re-presented to fishers at a formalised event. The presentation was based on the information presented in the advisory within this report using power point techniques and provided an opportunity to develop presentation material for recommendation in future PFSA projects. Approximately 30 fishers attended the event which was advertised at short notice by the DECR. The presentation slides and supporting text are shown in annex 2.

Table 4. Summary of the South Caicos management presentation based on the subjects presented and the information on each subject provided.

Subject:	Information:
Principles of Fisheries Management	UN FAO, CITES; Science and global examples
State of the conch fishery and setting the quota; Information utilized by stock assessment;	Overfished and overfishing definitions Information used in PFSA; Catch/effort model
Resource state: Overfished?	Fishers (prior) Scientific (catch/effort) Posterior (combined)
Resource state: Overfishing?	Fishers (prior) Scientific (catch/effort) Posterior (combined)
Stock status and recovery	Status of the fishery
Recovery?	Immigration Biological population growth
Recovery time	Fishers (prior) Scientific (catch/effort) Posterior (combined)
Scenarios: implications of management	Best: Not overfished, not overfishing Worst: Overfished, overfishing
Recommendations	Set quota at a lower level Stock will recover (5-8yrs) Support higher sustainable catches in the future

5.2 DECR

The PFSA findings were presented to the DECR in a meeting with the Director and associated staff. Recommendations based on the scientific advisory produced using the PFSA software were made and all materials developed during the fieldwork presented.

6.0 Conclusions

The TCI trial showed the PFSA technique could be applied quickly and effectively in the field, providing useful data beneficial to conch fishery stock assessment and management. The technique can be learnt quickly and a large number of fishers can be interviewed over a relatively short period. Most fishers were also enthusiastic about the opportunity to be involved and were willing to spend time to participate indicating benefits of the technique to co-management. This also allowed a considerable number of interviews to be completed in a relatively short time period, highlighting the PFSA method as a rapid technique. The successful production of a scientific advisory and rapid dissemination of outputs to stakeholders and the interest that the approach generated during the fieldwork all indicate that the technique can be successfully applied in other fisheries and benefit fisheries management on similar scales.

7.0 Acknowledgements

Considerable thanks are due to all of the staff at the Department for Environmental and Coastal Resources (DECR) for their help and participation during the course of the fieldwork, especially to Michelle Fulford and Judith Campbell for their input during the course of the project. Also, to Marsha Pardee and the School for Field Studies for their help and hospitality, and the fishers of South Caicos and Providenciales for taking part in the development of the PFSA technique.

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Annex 1: Itinery: Turks and Caicos Fieldwork

Date	Description of Activity
01/0703	Hotel Accommodation (Heathrow)
02/07/03	Depart London Heathrow
03/07/03	Arrive Providenciales International Airport
03/07/03	Accommodation arranged with Marsha Pardee
04/07/03	Meeting with Department for Environment and Coastal Resources
05/07/03	(DECR)
06/07/03	Trial interviews with DECR staff
07/07/03	Trial PFSA interviews with local consultants and interested parties
07/07/03	Depart Providenciales for South Caicos
07/07/03	Accommodation at the South Caicos School for Field Studies
07/07/03	Meeting with DECR staff in South Caicos; introduce PFSA and proposed work
08/07/03	PFSA technique introduced to fishers of South Caicos during
09/07/03	Fisherman's Day Workshop
10/07/03	PFSA interview data collection conducted
11/07/03	PFSA interview data collection conducted
12/07/03	PFSA interview data collection conducted
13/07/03	PFSA interview data collection conducted
14/07/03	Visit to Grand Turk
	Visit to Grand Turk
15/07/03	Medley, P. to South Caicos for PFSA interviews, Taylor, O. to Providenciales for PFSA interviews and DECR visit.
16/07/03	Medley, P. to South Caicos for PFSA interviews, Taylor, O. to Providenciales for PFSA interviews and DECR visit.
16/07/03	Medley, P. to South Caicos for PFSA interviews, Taylor, O. to
17/07/03	Providenciales for PFSA interviews and DECR visit.
18/07/03	Medley to Providenciales - DECR meeting
19/07/03	PFSA interviews
20/07/03	Data analysis and advisory preparation
21/07/03	Data analysis, advisory and presentation preparation
22/07/03	Data analysis, advisory and presentation preparation
23/07/03	Flight to South Caicos; DECR meeting, Presentation of findings to fishers
	Return to Providenciales, final debrief with DECR
	Flight from Providenciales - New York, New York – London Heathrow

Annex 2a. The South Caicos Presentation

Descriptive text for the power point projection presentation prepared for the dissemination of the PFSA findings to the fishers of South Caicos (TCI) is shown here. The notes apply to selected slides in the presentation. This was a first attempt. While successful, the way science is communicated to fishers could be greatly improved.

Slide 2: Principles

Scientific data collection aims to deal with the consequences of fishing by assessing the status of a fishery and taking in to account the uncertainty and risk that is inherent to any stock assessment (such as stock stochasticity brought about by natural variation in recruitment, changes in mortality etc). This allows successful management practices to be applied to maintain yields and the overall viability of a fishery.

Fisheries management can take place at a variety of scales: local, regional, national and international. International regulation comes from a variety of sources such as the United Nations Fisheries and Agriculture Organisation, the Marine Stewardship Council (MSC) and the Convention on International Trade in Endangered Species (CITES). CITES regulates the trade in threatened and endangered species, including the Queen Conch (*Strombus gigas*) and monitors the export quota for the TCI. Unsustainable harvesting of a resource will be addressed by CITES by reducing quota’s or closing fisheries completely by banning exports.

It is important to realise that successful fisheries management is possible as lessons are learnt from previous mistakes in fisheries management or indeed its non-compliance. The United States, New Zealand, Australia, Canada and the TCI are all areas where successful management has been applied, often after valuable fisheries have been lost and the cost and lessons directly learnt.

Slide 4: Overfished Definition

Ideally a fishery will be maintained in state that provides the maximum sustainable yield (MSY) thereby maximising the economic yield without depleting the resource. In simple terms fisheries can be considered to be in one of four states based on the terms over-fished and overfishing.

If a fishery is overfished the current biomass available to the fishery is less than 50% of the unexploited population size: historically more fish have been removed from the fishery than can be replaced by reproduction and recruitment, and continued fishing has prevented subsequent recovery. If a population is pushed below 50% of the unexploited stock size then the productivity of the stock also declines and increases in fishing effort will only maintain catches for a short period before more dramatic declines in catch are observed.

Slide 5: Overfishing Definition

Overfishing is a term applied to current events in a fishery. If fishermen are overfishing then they are removing fish faster than they can be replaced by natural population growth and the size of the stock is in decline. As a result catches cannot be sustained (or only temporarily by increasing effort) and eventually the stock will become overfished.

Slide 6: Getting it Right
Fisheries management aims to take into account over-fishing and the problems associated with over-fished stocks in order maximise sustainable yields from the stock. If fisheries management is not properly applied then a stock will be either overfished as too many targets are removed, or restrictions may be too harsh and under-estimate the productivity of the stock and thus limit economic gain. Good management seeks to maximise yield whilst also protecting the stock and accounting for problems associated with risk that are inherent to fisheries.

Slide 7: Sources of Information
The Queen Conch (*Strombus gigas*) fishery requires a stock assessment that allows a quota to be set for total landings and export. To achieve this we have incorporated traditional scientific data based on the catch and effort data recorded at the plants with the PFSA interview data from the fishermen. By representing each type of data we can compare scientific and fisher opinion, and then combine the data to represent the fishery and management options in the form of a posterior output.

Slide 8: Scientific Model
This figure shows the time-series catch and effort data that has been collected for the Conch (*Strombus gigas*) fishery. Data collection extends back to the early 1900's but more recent years are shown here. The figure compares the catches recorded at the processing plants with those predicted by the Schaefer logistic model which best represents this single species fishery. It is clear that the model has accurately forecasted stocks, however there is the suggestion from the observed data that the stock maybe in the beginning of a decline as the model and observed data points diverge in recent years. This could be accounted for by undeclared/recorded catches through poaching or by the dried-conch market.

Slide 9: Overfished?
If a fishery is over-fished then the current catch per day must be less than 50 % of the unexploited catch per day. I.e. the catch landed is less than half of the catch that would be landed if the fishery was unexploited. In this position the stock size is small and yields are relatively low as population growth is diminished.

Slide 10: Resource State (Fishers)
The PFSA questionnaire was used to identify what the fishers thought the current status of their fishery is. Typically, most thought that the number of conch on the bank was less than 50% of what the bank could support if the fishery was unexploited (i.e. that the fishery is overfished). Others thought that the fishery was fully exploited or that more fishing was possible – but they do not represent the majority.

Slide 11: Resource State (Scientific)
The scientific data from the catch and effort time-series supports the fishers view that the fishery is in an over-fished state and that catches are considerably lower than could have once been sustained.

Slide 12: Resource State (Combined)
Unsurprisingly when the interview and scientific data are combined the posterior opinion is that the fishery is over-fished (i.e. the current biomass / population size of conch is less than 50%of the population size that the banks could support).

Slide 13: Overfishing?
Now let us consider fishing activity in the fishery. Is there too much fishing (overfishing), the right level? or is there room for an increase in effort? As the fishery is currently overfished then we also need to consider the growth of the stock and how this affects its recovery rate.

Slide 14: Too Much Fishing?
From the fishers interview data the suggestion is that there is to much fishing taking place, or at the very least fishing is occurring at a maximum. Few fishermen thought there was room for anymore fishers or increased effort on the banks. One of the opinions regularly expressed was that there currently enough 'belongers' involved in the Conch fishery and that non-belongers (non-TCI residents) should be excluded from the fishery.

Slide 15: Quota Level (Fisher)
The fishers' opinion was also asked in regard to setting the quota. In the three scenarios the majority of the fishermen thought that the quota could be increased, relatively few thought that there was a need to reduce the quota to protect stocks.

Slide 16: Quota Level (Scientific)
However the scientific data suggests that the quota should not be increased and suggests that the quota is currently set at a maximum, whilst there is also a suggestion that the quota may in fact be too high already and that over-fishing maybe occurring.

Slide 17: Quota Level (Combined)
By combining the scientific and interview data the position becomes more complicated as there is little indication from the catch and effort data that there is room for the quota to be increased.

Slide 19: Conch Stock Recovery
During the interview fishers were asked about the conch stock and its recovery rate. When considering recovery there are two fundamental issues: Conch movement, and reproduction and subsequent stock growth.

Slide 20: Questionnaire Recovery Time
Most fishers thought that the recovery time for the conch fishery was very short, in most instances less than two years. However, it is the scientists' opinion that the question and the manner in which it was presented may have resulted in inaccurate data collection in some instances. The phrasing of these questions needs careful consideration and standardisation to avoid error. Many fishermen used their experience of the closed season to guide how long recovery would take. Some fishers simply implied that the closed season was the right amount of time as it allowed them to obtain similar catch rates the next season. However, this question is most concerned with how long it would take for the fishery to recover to an unexploited state (not the overfished state that is currently represented). Other fishermen were of the opinion that the fishery would take considerably longer for the fishery to recover. 30% thought that the fishery would take 2-4 years or more to return to unexploited levels.

Slide 21: Considerations
The fishers' opinion must also include biological aspects of the stock such as movement and biological growth (reproduction). In the fishers opinion from the data set collected, conch recovery would take less than two years. However to reach

maturity a new recruit to the fishery would take three years or more to reach sexual maturity. Thus much of the perceived recovery that is observed by the fishermen must come from immigration. The conch fishery does not encompass the whole bank area and many areas are inaccessible to collectors due to the depth of water and the logistics of free diving. During the closed season it is thought that conch disperse over the bank from areas which have not been exploited by the fishery and re-populate areas of the bank that the fishery will access at the beginning of the next season.

Slide 22: Immigration
This figure provides a visual representation of conch immigration into fishing areas that can be used in explanation to fishermen.

Slide 23: Population and Immigration
This figure also shows immigration but represents an over-fished fishery and reduced numbers of conch. As a result catches within the fished areas decrease because there is less immigration from surrounding areas.

Slide 24: Scientific Data Recovery Time
As opposed to the information provided by the fishermen, the scientific data shows that recovery of the fishery to pre-exploitation population size would take at least two years, and most probably 4 years or longer. From the data collected eight years would be a reasonable time to allow for a complete recovery of the fishery.

Slide 25: Combined Data Recovery Time
When the two data sets are combined to generate the posterior, the strength of the scientific data shifts the fishers' opinion so that the output concurs strongly with the scientific position. This is largely a factor of the uncertainty displayed in the fishers' collective opinion, whilst the time series data is more heavily weighted. Complete recovery of the fishery to unexploited levels could be expected to take in the region of eight years.

Slide 26: Stock Status Summary
What is the current status of the Queen Conch Fishery in the TCI? In the worst case scenario a stock will be overfished and the fishers will also overfishing, quickly driving the stock to collapse. In the best scenario the stock won't be overfished and overfishing will not be occurring.

Slide 27: Fisher Opinion
There are four basic scenarios that we can consider when assessing a stock's status. Each is defined in terms of overfishing or not, and overfished or not. The figure shows these four scenarios. The blue bars represent the better positions for the fishery and the red the worse. In the worst instance a fishery will be overfished and the fishers will be overfishing. The fishers' opinion from the interview suggests that the fishery is overfished, the fishery has been depleted previously by overfishing and then not allowed to recover. However their data also suggests that the fishers are not currently overfishing: they are not depleting the fishery further. The fishery has entered a state where yields are sustained but at a low level compared to their potential given adequate recovery.

Slide 28: Scientific Opinion
Scientific data supports the view that the fishery is overfished, but that fishers aren't currently overfishing. There is a very high probability that this is the correct assumption for the status of the conch stock.

Slide 29: Combined Opinion
The posterior reflects the similar opinion of the fishers and the scientific data.

Slide 30: Summary
In summary the stock is overfished but overfishing is not occurring under the current quota. This position is likely to change if the quota is altered. Increasing the quota would increase mortality and push the fishery towards an overfishing state, whilst decreasing the quota would reduce current catches but allow the stock to recover. In time this would result in more conch on the bank and higher sustainable quotas in the future.

Slide 31: Summary
The scientific advisory for the conch fishery is to reduce the quota to maximise recovery. A low quota now will allow a more profitable fishery in the relatively near future.

Annex 2b. Presentation Slides

The Conch Quota

A Scientific Advisory
Paul Medley
Oliver Taylor
Fishermen of South Caicos

Principles

- Science: Deals with consequences
- Uncertainty and risk
- Organisations: UN FAO, MSC, CITES offer guidelines
- Other countries: USA, New Zealand, Australia, Canada, Turks and Caicos: Experiences and practice

State of the Fishery

- What you do not want the fishery to be: Overfished
- What you do not want to be doing: Overfishing

Overfished Definition

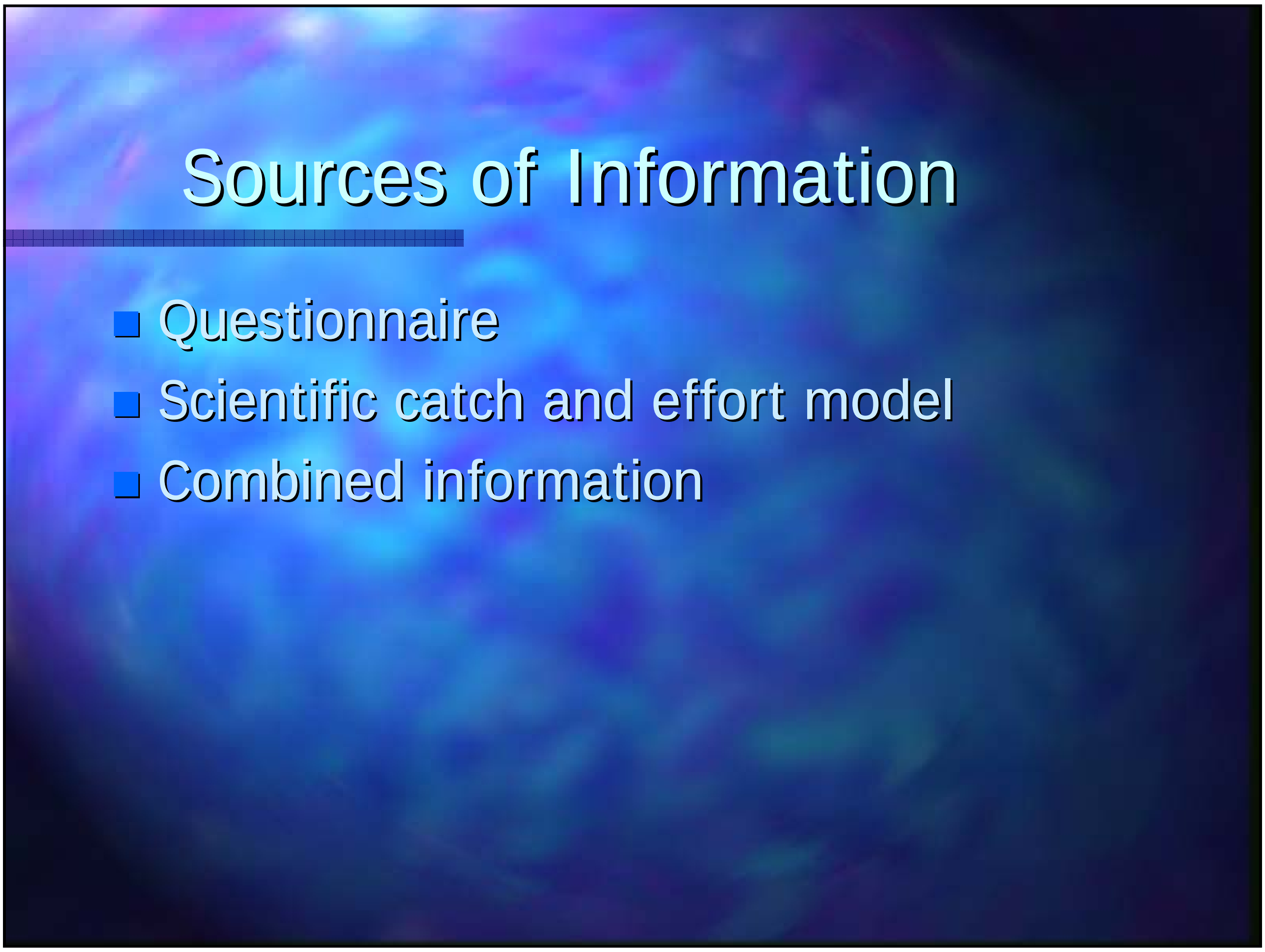
- Below 50% unexploited stock size
- Productivity of stock falls below maximum
- Total catch falls as effort increases!

Overfishing Definition

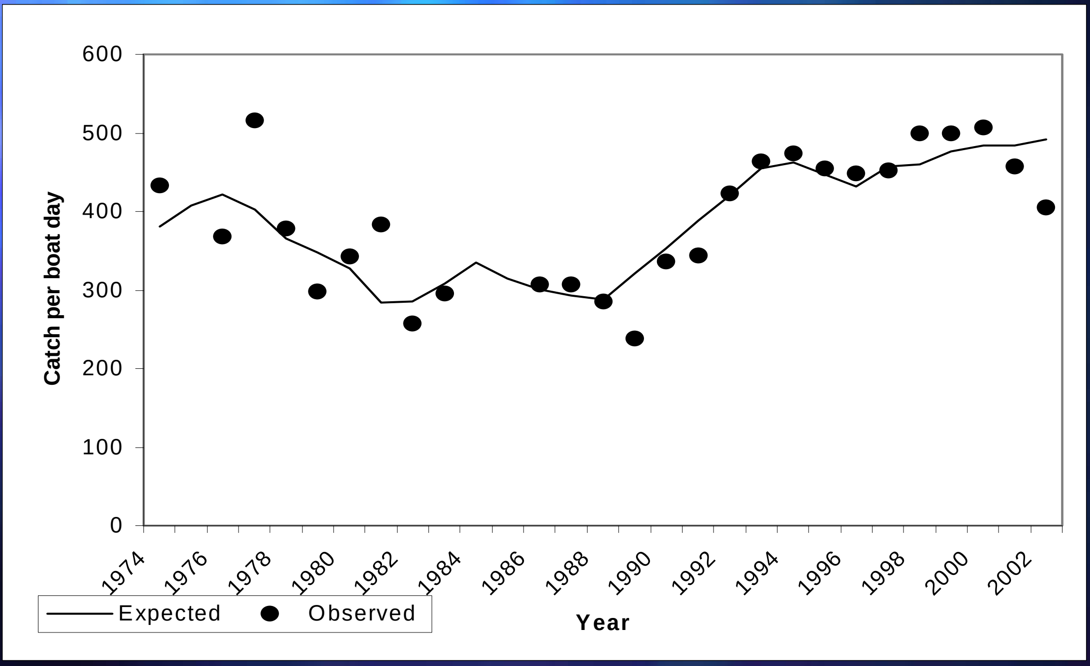
- Catches cannot be sustained
- Stock will become overfished eventually

Getting it right

- Too optimistic and you overfish
- Too pessimistic and you do not take advantage of your resources

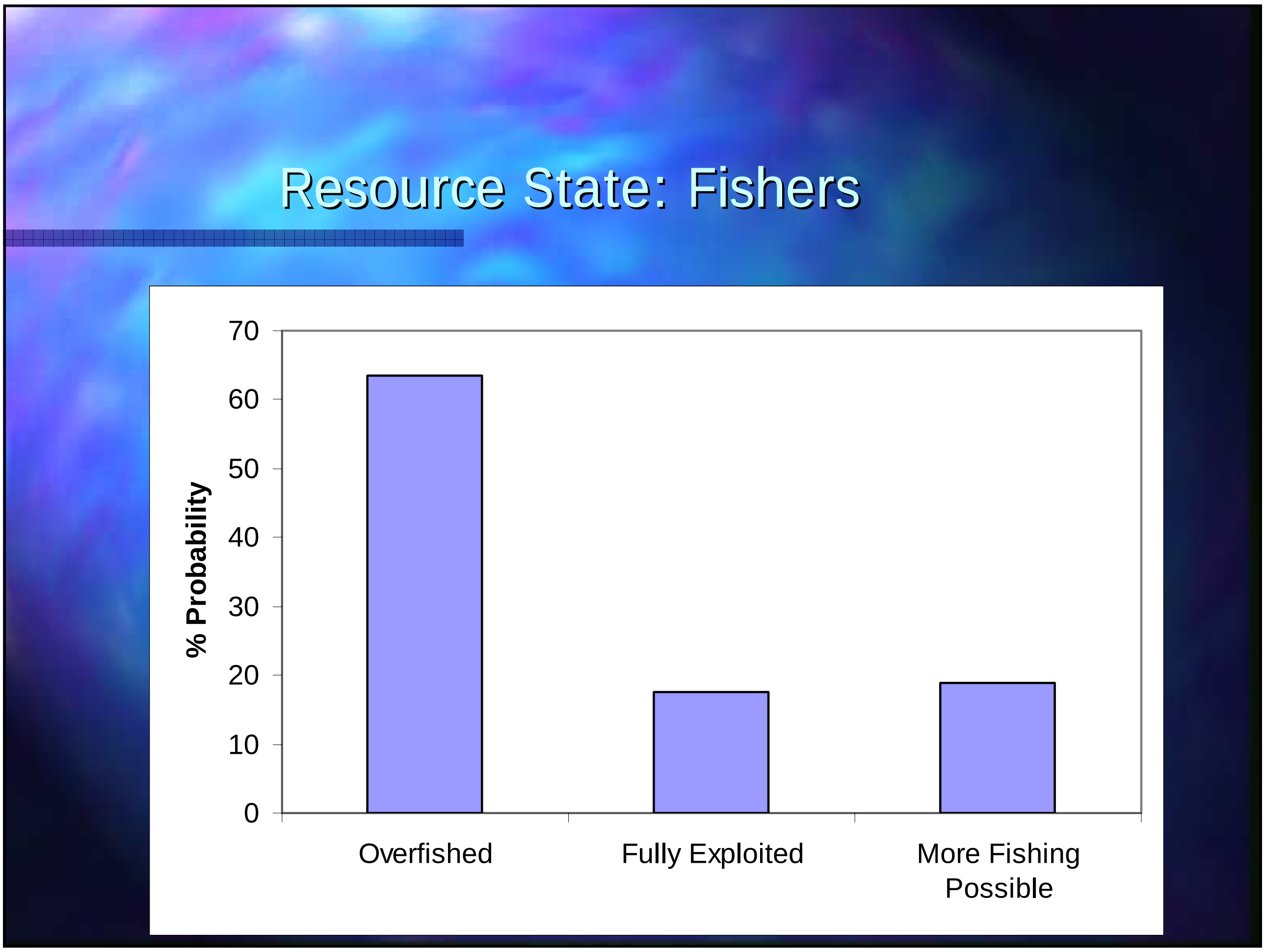

Sources of Information
Questionnaire
Scientific catch and effort model
Combined information

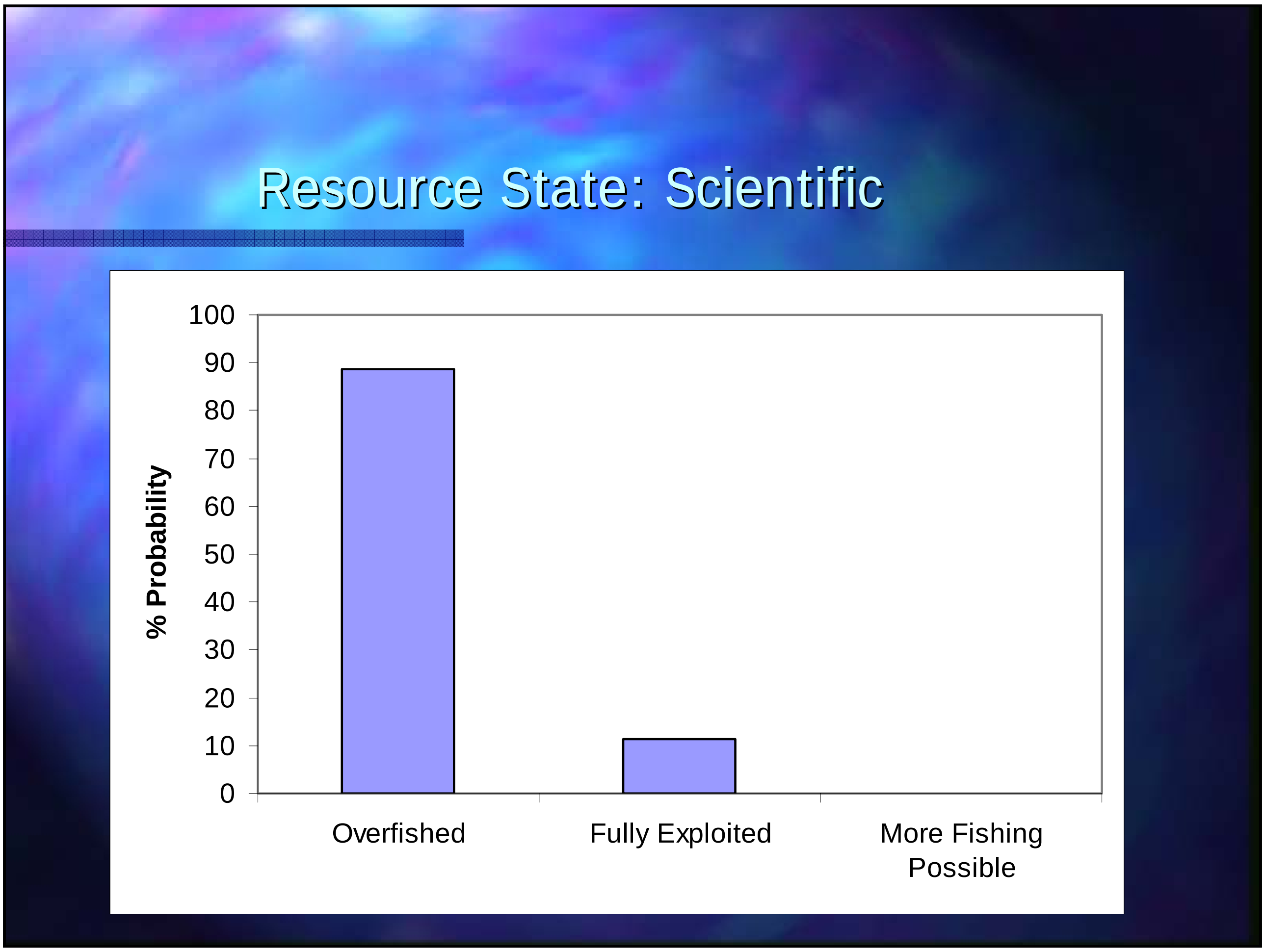
Scientific Model



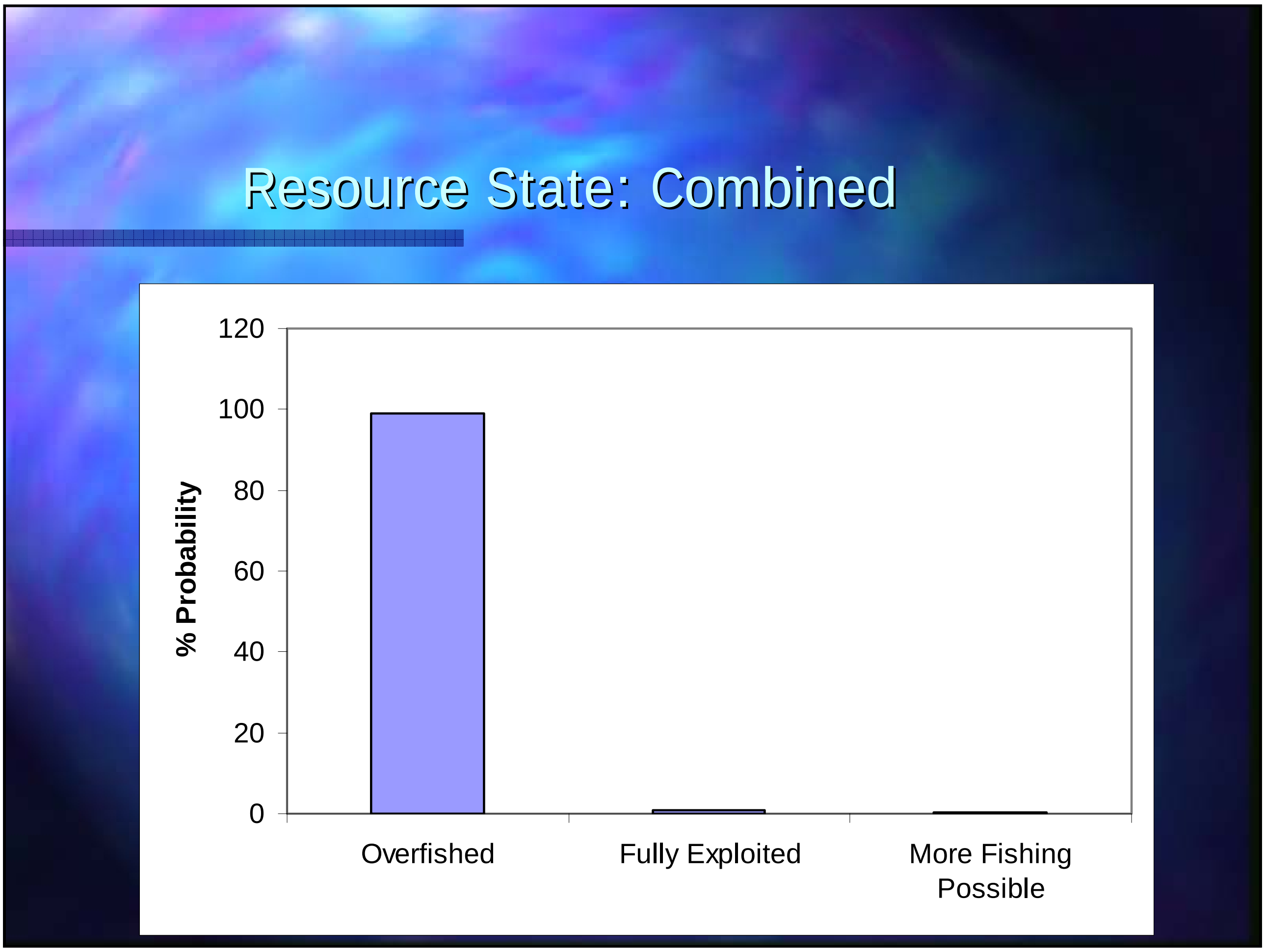
Overfished?

- The current catch per day as a proportion of the unexploited catch per day


Resource State: Fishers
% Probability
70
60
50
40
30
20
10
0
Overfished
Fully Exploited
More Fishing Possible



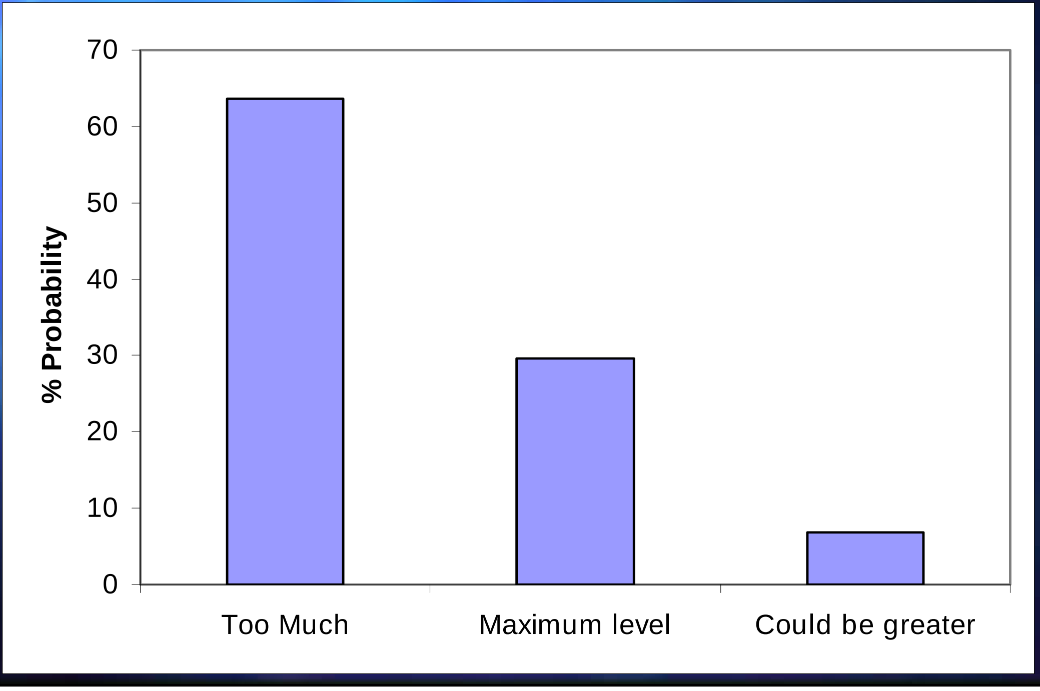
Resource State: Scientific
% Probability
100
90
80
70
60
50
40
30
20
10
0
Overfished
Fully Exploited
More Fishing Possible


Resource State: Combined
% Probability
120
100
80
60
40
20
0
Overfished
Fully Exploited
More Fishing Possible

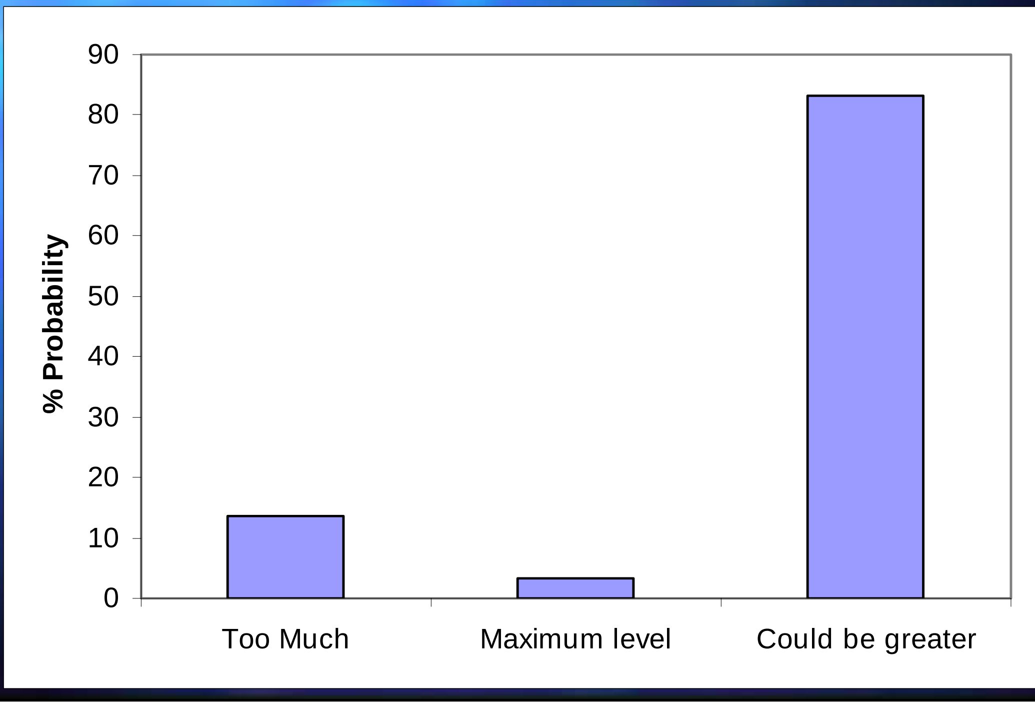
Overfishing?

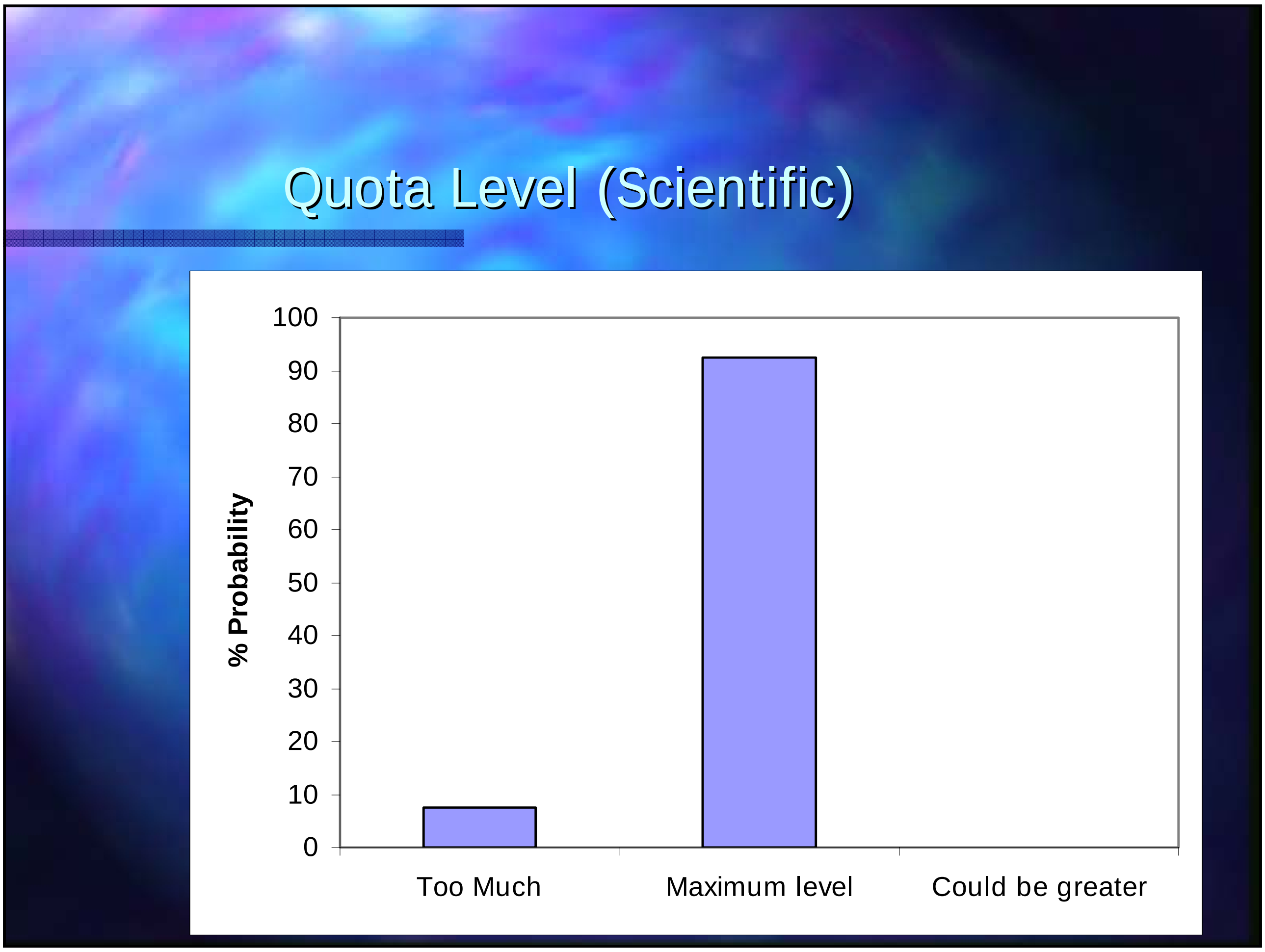
- Too much fishing, just right or could be greater
- Growth of stock, depends on its state and the rate of recovery

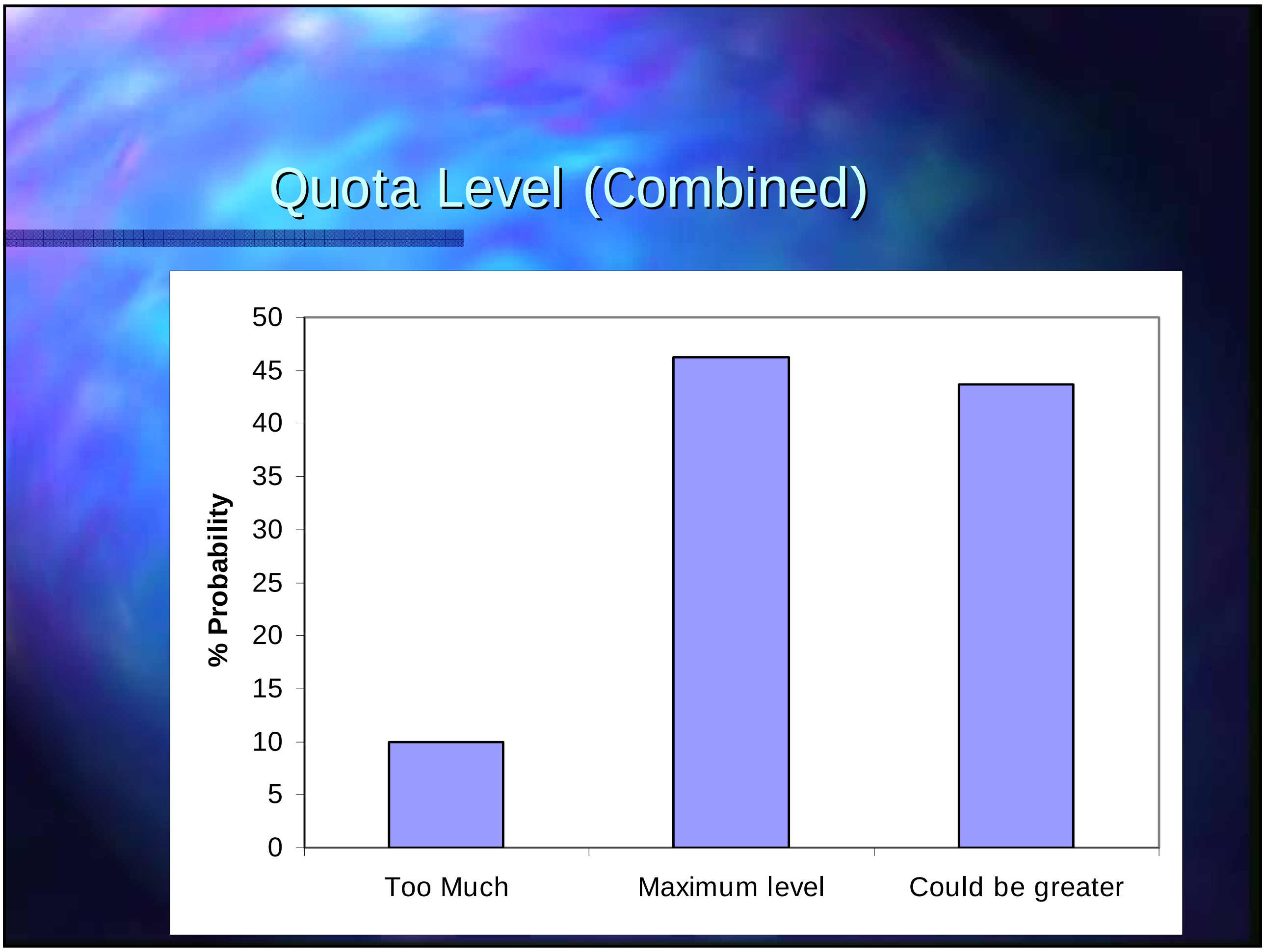
Too Much Fishing?



Quota Level (Fisher)




Quota Level (Scientific)
% Probability
100
90
80
70
60
50
40
30
20
10
0
Too Much
Maximum level
Could be greater



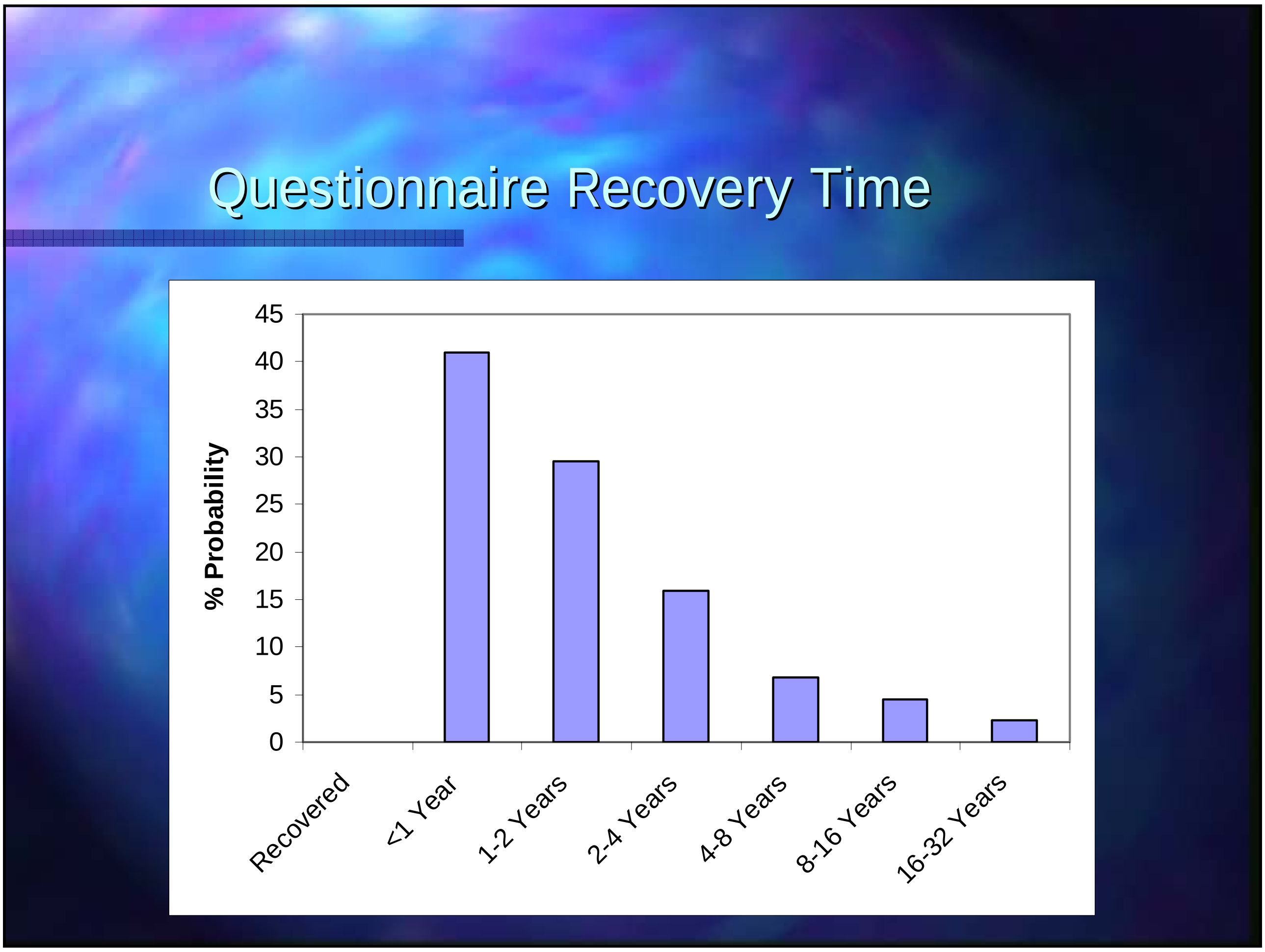
Quota Level (Combined)
% Probability
50
45
40
35
30
25
20
15
10
5
0
Too Much
Maximum level
Could be greater

Part 2

- Conch Stock and Recovery
- Status of the Conch fishery

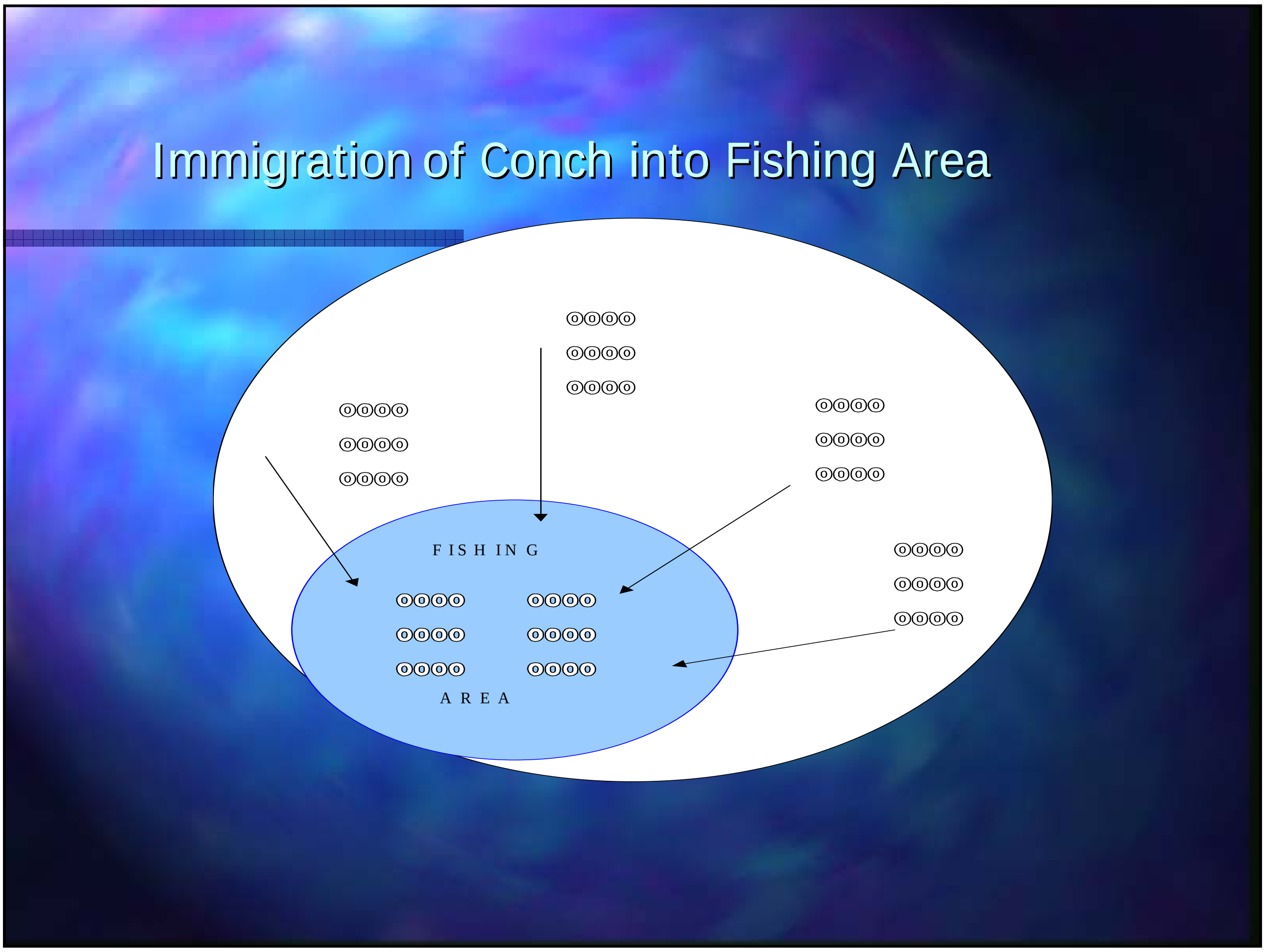
Conch Stock Recovery

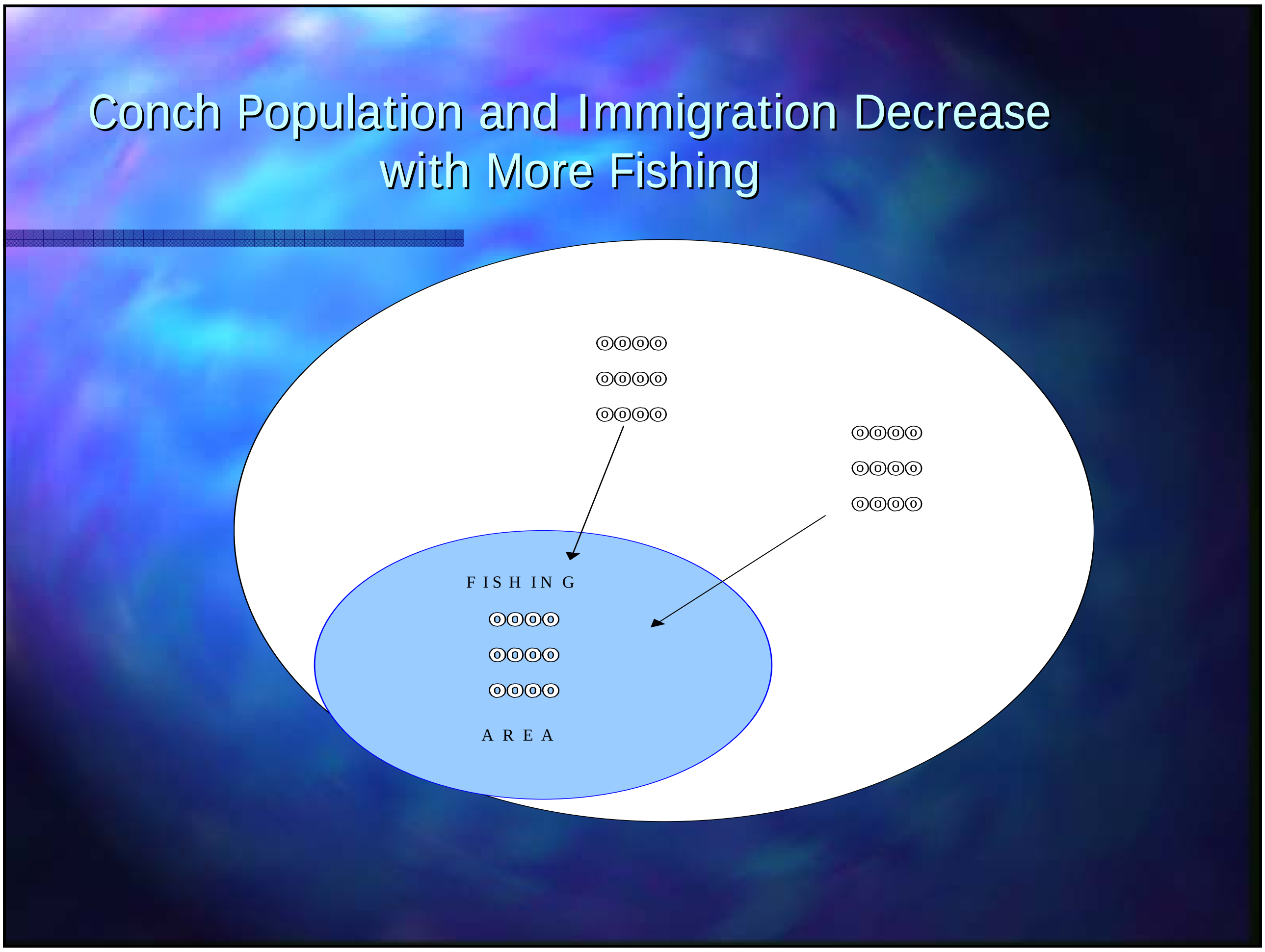
- Questionnaire: How long the stock would take to recover
- The two issues are:
  - Conch movement
  - Reproduction and stock growth

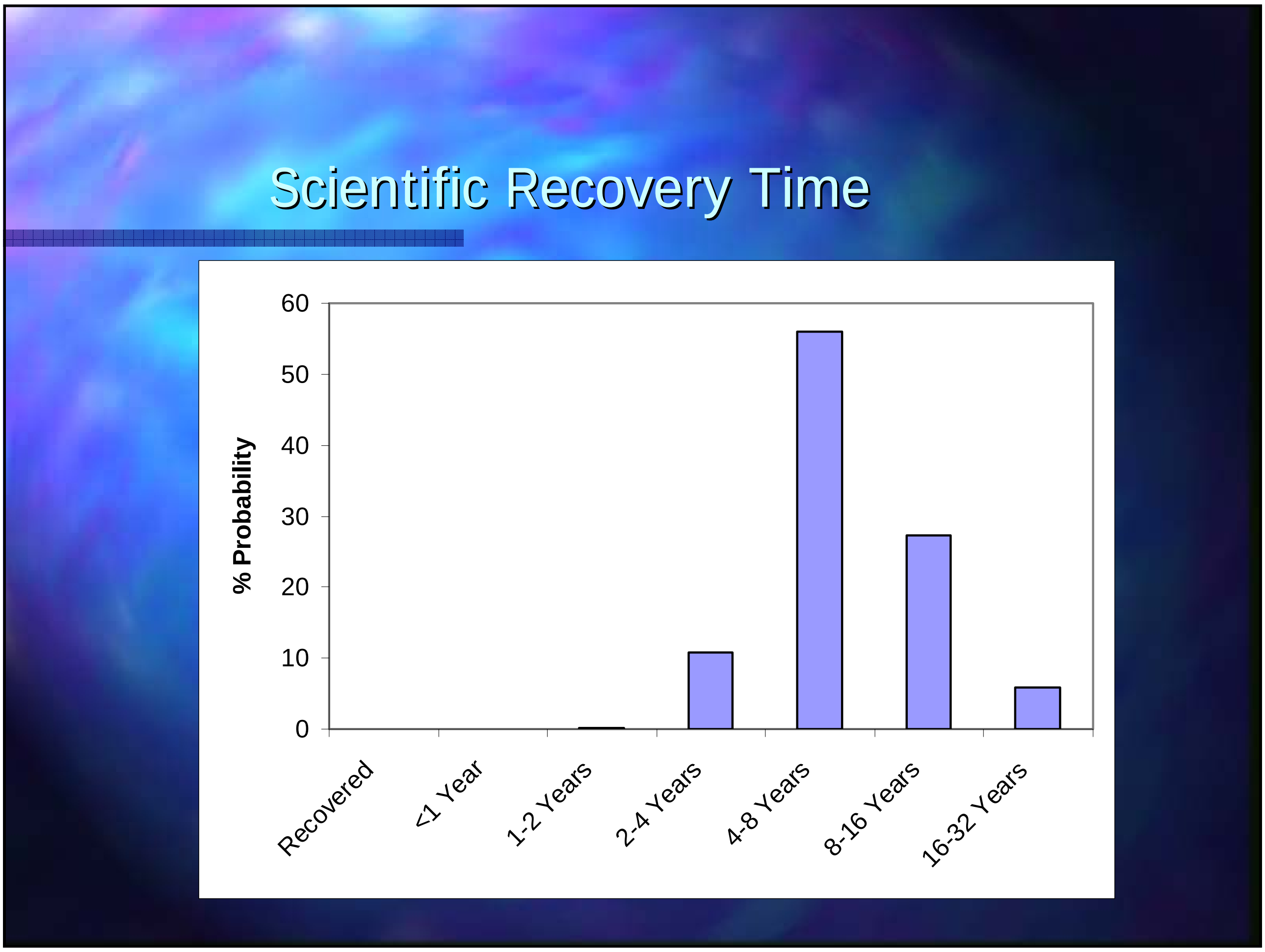

Questionnaire Recovery Time
% Probability
45
40
35
30
25
20
15
10
5
0
Recovered
<1 Year
1-2 Years
2-4 Years
4-8 Years
8-16 Years
16-32 Years

Considerations

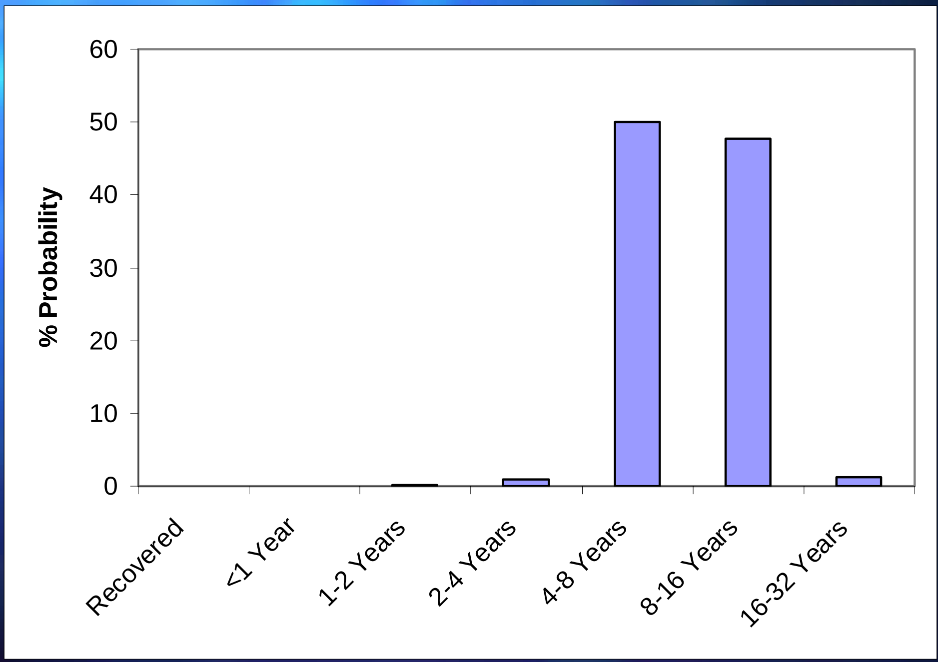
- Conch movement is fast
- Biological growth is slow


Immigration of Conch into Fishing Area
FISHING
AREA


Conch Population and Immigration Decrease with More Fishing
ⓞⓞⓞⓞ
ⓞⓞⓞⓞ
ⓞⓞⓞⓞ
ⓞⓞⓞⓞ
ⓞⓞⓞⓞ
ⓞⓞⓞⓞ
F I S H I N G
ⓞⓞⓞⓞ
ⓞⓞⓞⓞ
ⓞⓞⓞⓞ
A R E A

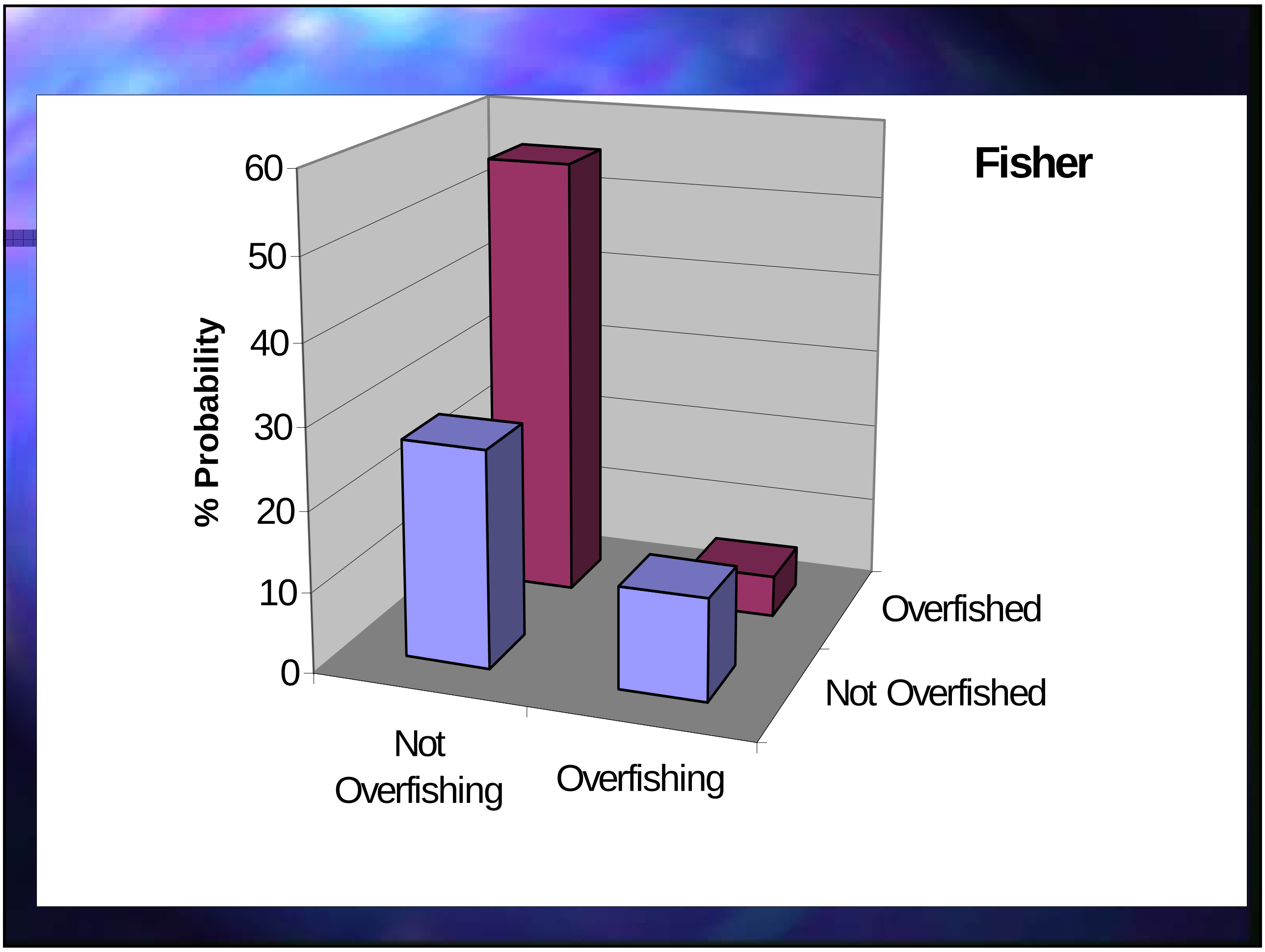

Scientific Recovery Time
% Probability
60
50
40
30
20
10
0
Recovered
<1 Year
1-2 Years
2-4 Years
4-8 Years
8-16 Years
16-32 Years

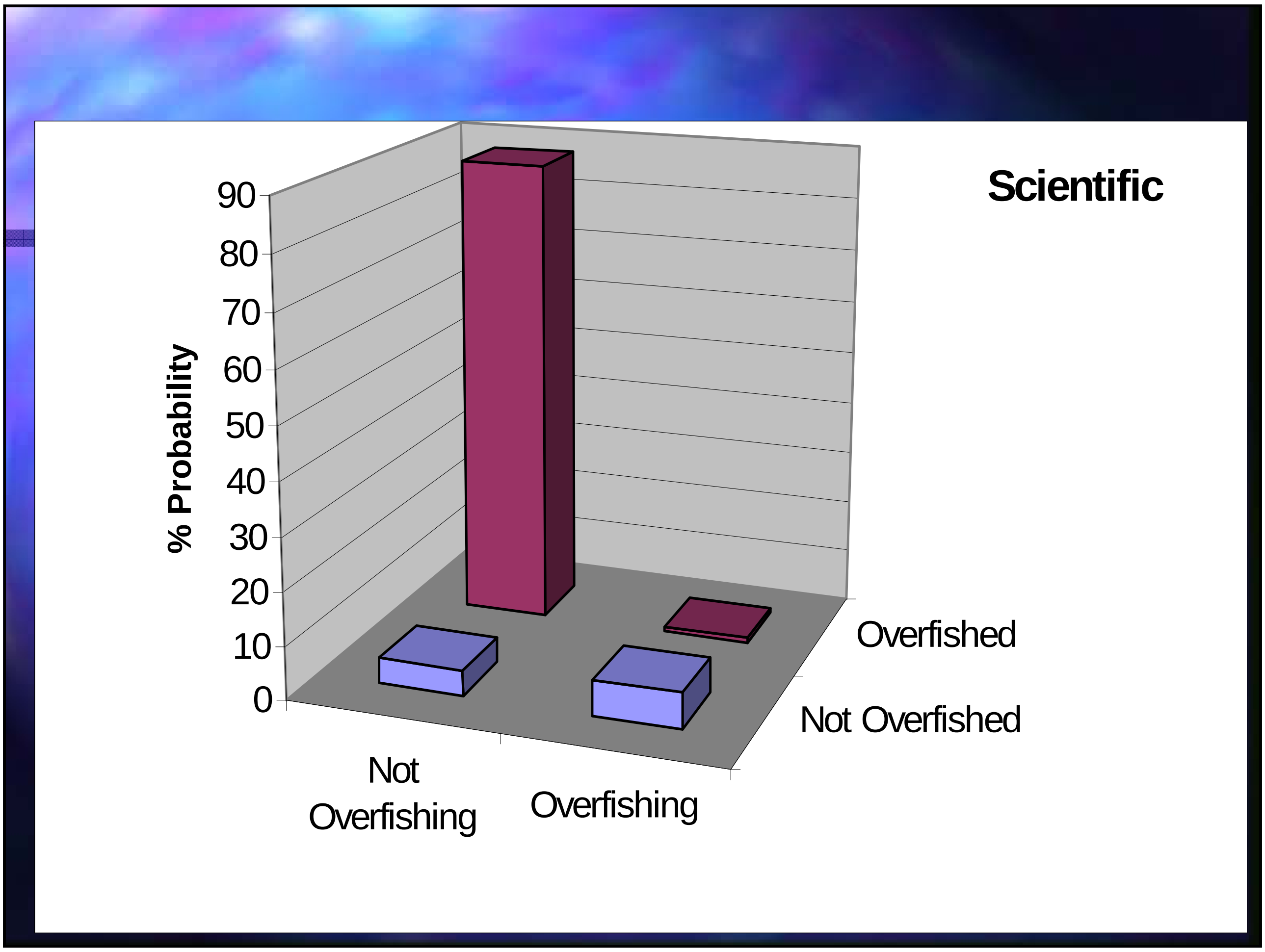
Combined Data Recovery Time



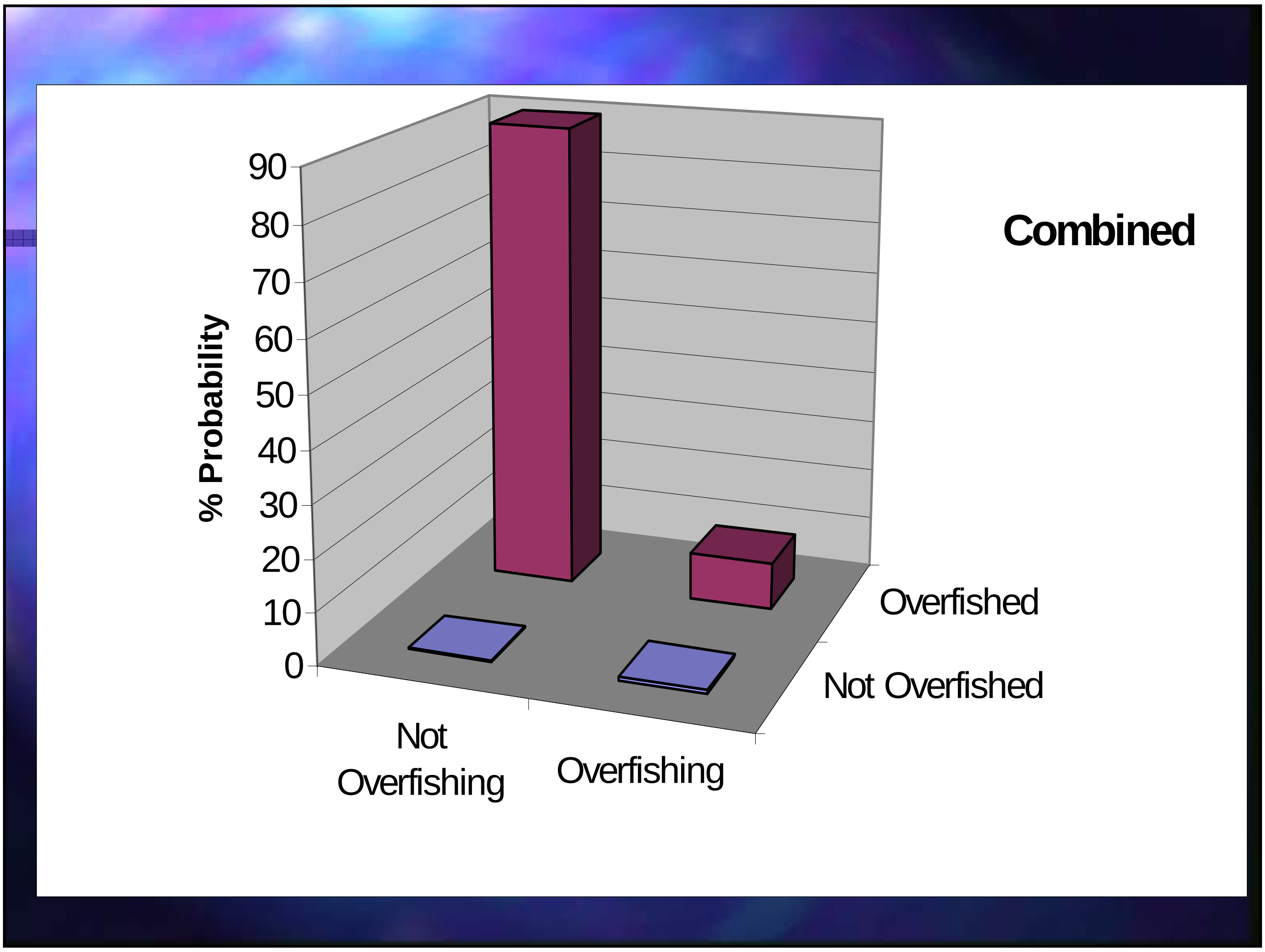
Stock Status Summary

- Scenarios:
- At worst a stock is overfished and you are overfishing
- At best the stock is NOT overfished and you are NOT overfishing


Fisher
% Probability
60
50
40
30
20
10
0
Not Overfishing
Overfishing
Overfished
Not Overfished



Scientific
% Probability
90
80
70
60
50
40
30
20
10
0
Overfished
Not Overfished
Not Overfishing
Overfishing

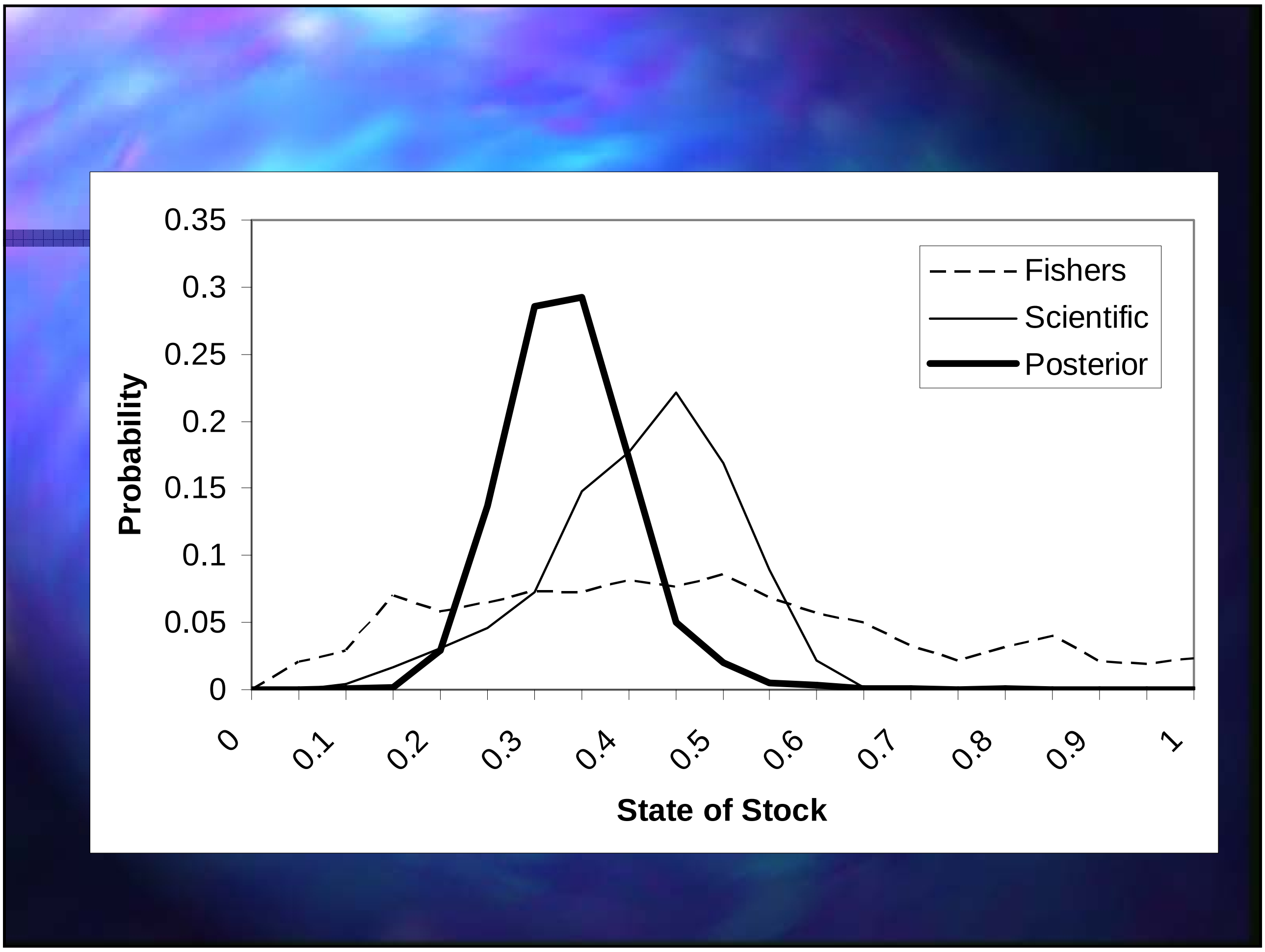

Combined
% Probability
90
80
70
60
50
40
30
20
10
0
Not Overfishing
Overfishing
Overfished
Not Overfished

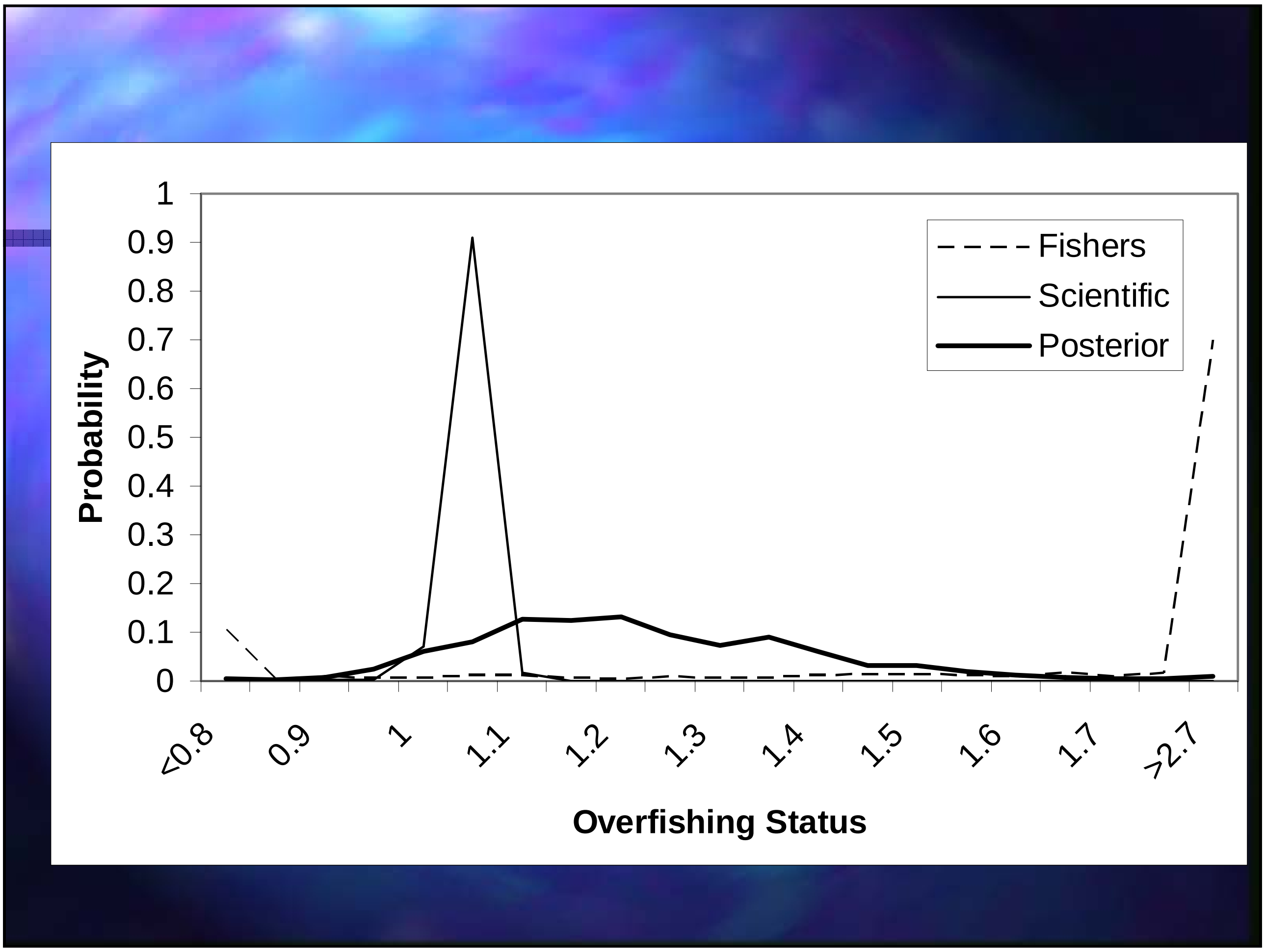
Summary

- Stock is recovering
  - The stock is overfished, but you are not overfishing with the current quota
- Scientific information helps make sensible choices

Summary

- Quota should be kept as low as possible to allow stock to grow
- A low quota now will allow higher quotas and higher catch per day within 5-8 years


Probability
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
State of Stock
Fishers
Scientific
Posterior



Fishers
Scientific
Posterior
Probability
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
<0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
>2.7
Overfishing Status