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MEDITERRANEAN ACTION PLAN**

Seventeenth Meeting of SPA/BD Focal Points

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Agenda Item 2: Conservation of Species and Habitats

5.2. Updating of the Action Plan for the conservation of cartilaginous fishes (Chondrichthyans) in the Mediterranean Sea

Socio-Economic Impact Study on Implementing Conservation Measures for Cartilaginous Species in the Gulf of Sirte, Libya

Note:

The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of Specially Protected Areas Regional Activity Centre (SPA/RAC) and United Nations Environment Programme concerning the legal status of any State, Territory, city or area, or of its authorities, or concerning the delimitation of their frontiers or boundaries.

Note by the Secretariat

1.   In December 2023, the Contracting Parties to the Barcelona Convention took an important step forward by adopting Decision IG.26/4 at COP 23 in Portoroz. This decision added eight additional cartilaginous species to Annexes II and III of the SPA/BD Protocol, enhancing their protection across the Mediterranean. While this represents critical progress for conservation, implementing such measures requires careful consideration of how they might affect coastal communities whose livelihoods depend on fishing.

2.   Within the implementation of this decision, SPA/RAC has assisted the elaboration of the national Action Plan for the conservation of cartilaginous fishes in Libya and the conduction of a rapid assessment of elasmobranchs in Libya. While the socio-economic impact study on implementing conservation measures for cartilaginous species in the Gulf of Sirte, Libya, the preliminary draft for which is given in this document is coordinated by Plan Bleu.

3.   This document is submitted to the 17th Meeting of the SPA/BD Focal Points for information.

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Executive Summary

1. This study evaluates the socio-economic impacts of implementing conservation measures for cartilaginous species listed in Annexes II and III of the SPA/BD Protocol under the Barcelona Convention in the Gulf of Sirte, Libya. We've focused on assessing the effects on local fisheries and coastal communities while developing practical mitigation strategies that balance ecological conservation with socio-economic sustainability.

2. This first draft presents our preliminary findings based on data we've collected from Western Sirte (Misrata - Sirte) and Eastern Sirte (Ras Lanuf) through questionnaires, focus group discussions, and key informant interviews. We're still gathering data from Central Sirte, which will be incorporated into our final report.

3. Our field research reveals that cartilaginous species represent a significant but variable component of fishing activity across the Gulf of Sirte. About a third of fishermen (34%) report regular or frequent catches of sharks and rays, though the economic dependency varies considerably between regions, with notable differences between Western and Eastern Sirte. Perhaps most tellingly, over 90% of respondents told us they catch protected cartilaginous species as bycatch, highlighting the direct relevance of conservation measures to everyday fishing practices.

4. Encouragingly, we found generally positive attitudes toward conservation measures among fishermen. Nearly three-quarters (74.5%) expressed willingness to participate in sustainable fishing training programs. When asked about preferred support mechanisms, financial assistance topped the list (46.8%), followed by training in alternative fishing practices (36.2%). These preferences suggest viable pathways for implementation that could minimize economic disruption.

5. Based on these initial findings, we recommend a phased implementation approach with targeted financial support mechanisms, investment in gear modification programs, development of alternative fisheries focusing on non-threatened species, and comprehensive stakeholder engagement in conservation planning and enforcement.

6. The full study will incorporate additional findings from Central Sirte, as well as deeper insights from our focus group discussions and key informant interviews

1. Introduction

1.1 Background

7. The Mediterranean Sea stands as one of the world's most significant marine biodiversity hotspots, supporting over 17,000 marine species, many found nowhere else on Earth. But this remarkable diversity faces mounting threats from human activities - overfishing, pollution, habitat destruction, and climate change are pushing many species toward extinction. Among the most vulnerable are cartilaginous species (sharks, rays, and chimaeras), which are particularly susceptible to population decline due to their biological characteristics: they grow slowly, mature late, and produce few offspring.

8. In December 2023, the Contracting Parties to the Barcelona Convention took an important step forward by adopting Decision IG.26/4 at COP 23 in Portoroz. This decision added eight additional cartilaginous species to Annexes II and III of the SPA/BD Protocol, enhancing their protection across the Mediterranean. While this represents critical progress for conservation, implementing such measures requires careful consideration of how they might affect coastal communities whose livelihoods depend on fishing.

1.2 The Gulf of Sirte: Ecological and Socio-Economic Context

9. The Gulf of Sirte (also known as Gulf of Sidra) represents one of Libya's most ecologically important coastal regions. Its shallow waters and rich nutrient influx create a mosaic of diverse marine habitats: sandy substrates, lush seagrass meadows, photophylous algae communities, rocky substrates, detrital bottoms, and dramatic coastal cliffs (Hamza et al., 2011). During summer, water temperatures in the shallow areas can reach a sweltering 30°C, while salinity remains relatively high (38-39) due to the arid climate that drives high evaporation rates and minimal freshwater input.

10. The ecological significance of the Gulf hasn't gone unnoticed internationally. It's designated as an Ecologically or Biologically Significant Marine Area (EBSA) under the Convention on Biological Diversity and overlaps with five Key Biodiversity Areas (Tawuoryhe Sebkha, Gulf of Sirte, Geziret Garah, Benghazi, and Jabal al Akhdar). Spanning approximately 40,478 km², the region provides critical habitat for several threatened cartilaginous species, including the Critically Endangered Smoothback Angelshark (*Squatina oculata*). The Gulf also serves as an important nursery ground for species like the Angelshark (*Squatina squatina*), earning its recognition as an Important Shark and Ray Area (ISRA) based on both vulnerability criteria and its role as a reproductive sanctuary.

11. From a socio-economic perspective, the Gulf sustains numerous fishing communities spread across active landing sites where diverse fishing methods support local livelihoods. According to fisheries data (Lamboeuf et al. 2000 & Filogh, 2019), about 23% of Libya's artisanal fishing fleet – some 422 vessels – operate in the Gulf of Sirte region. Local fishermen primarily employ set gillnets, longlines, and traditional gear like Kellabia nets. These fishing practices, while essential for local economies, may inadvertently contribute to the decline of cartilaginous species if not managed with sustainability in mind.

1.3 Cartilaginous Species Conservation Status

12. Cartilaginous species throughout the Mediterranean face alarming population declines. Many are now listed as critically endangered or endangered on the IUCN Red List, reflecting their precarious status. The SPA/BD Protocol under the Barcelona Convention highlights conservation priorities for these species across member states, with 25 shark and ray species currently listed in Annex II (Endangered or Threatened Species) and 11 species in Annex III (Species Whose Exploitation is Regulated).

13. Despite existing protective measures, these vulnerable species continue to face significant threats from bycatch, illegal fishing, and habitat destruction. The recent Decision IG.26/4 expanded this protection by adding eight additional cartilaginous species to these annexes, prompting the need for detailed impact assessments in coastal regions like the Gulf of Sirte.

1.4 Study Objectives

14. Our study addresses two primary objectives as outlined in the consultancy Terms of Reference:

15. Assess Socio-Economic Impacts: We're evaluating how the inclusion of eight additional cartilaginous species in Annexes II and III of the SPA/BD Protocol might affect local economies and fisheries in the Gulf of Sirte. We're particularly interested in understanding their commercial importance and role in local livelihoods.

16. Propose Mitigation Measures: Based on our findings, we're developing practical strategies to minimize negative impacts on fisheries and communities while achieving conservation objectives. This includes identifying alternative target species that could reduce reliance on threatened cartilaginous species.

2. Methodology

2.1 Research Approach

17. For this study, we employed a mixed-methods approach that combines quantitative and qualitative research techniques. This allowed us to build a comprehensive picture of the socio-economic landscape while capturing the nuanced perspectives of local fishermen and community stakeholders. By triangulating data from multiple sources, we've worked to ensure our findings are robust and our recommendations contextually appropriate.

2.2 Study Area and Field Survey Design

18. We divided the Gulf of Sirte into three distinct sub-regions to capture the geographic variations in fishing practices and socio-economic conditions:

19. Western Sirte (Misrata-Sirte): This stretches features sandy beaches punctuated by rocky outcrops and salt marshes. It's home to significant fishing activity centered around major landing sites like Qasar Ahmed (Misrata), Al-Hisha, Tawergha, and Al-Washka. Fishermen here primarily use gill nets (trammel nets), hooks and lines, Kellabia nets, and longlines to target small pelagic fish, demersal species, cartilaginous species, and cephalopods.

20. Central Sirte (Sirte-Ras Lanuf): Characterized by extensive salt marshes, shallow coastal waters, and mixed sandy and detrital substrates. Key landing sites include Sirte and several salt marsh areas (Sultan, Besher, Kweim, Shwerab, Karkora), as well as Al-Khamseen. Fishing here often involves Kellabia nets (especially from February to May), longlines, and mixed gear approaches targeting cartilaginous species, large pelagic fish, and demersal fish.

21. Eastern Sirte (Ras Lanuf): This area features rocky shores, seagrass meadows, and deeper offshore waters. The coastline shows the influence of industrial development, including oil refineries and ports. Key landing sites include Ras Lanuf, Shatt Al-Bedin, and Zueitina Port. Fishermen here primarily use longlines, gill nets, and large hooks to target deep-water fish, large pelagic species, and various ray species.

22. This initial draft presents findings from Western and Eastern Sirte, where we've completed our field surveys. We're still gathering data from Central Sirte, which will be incorporated into our final report, along with additional insights from our focus group discussions and key informant interviews.

2.3 Data Collection Methods

2.3.1 Survey Instrument

23. We developed a structured questionnaire to gather primary data from fishermen throughout the Gulf of Sirte. Our survey covered:

- General information and demographics (age, education, fishing experience)
- Fishing effort and practices (fishing days, gear types, target species)
- Economic dependency on fishing (household income contribution)
- Shark and ray fishing frequency and contribution to income
- Environmental perceptions and awareness
- Attitudes toward conservation measures
- Willingness to adopt alternative livelihoods or practices

24. The survey combined quantitative measurement of key indicators with qualitative insights through open-ended questions that captured fishermen's perspectives, concerns, and suggestions in their own words.

2.3.2 Data Collection Strategy

25. Our field research employed multiple approaches to ensure comprehensive data collection:

- Face-to-Face Interviews: Our team visited landing sites throughout the region, sitting down with fishermen to conduct structured interviews about their socio-economic conditions, fishing practices, and awareness of conservation issues. These personal interactions allowed us to build rapport and gather more honest responses.

- Focus Group Discussions (FGDs): We organized group discussions with fishermen, community representatives, and fishery stakeholders to gain richer qualitative insights into the challenges they face and their attitudes toward sustainable fishing practices.

- Field Observations: We conducted direct observations of fishing operations, gear usage, and species landed to validate and contextualize questionnaire responses. This gave us a first-hand look at the fishing practices described by respondents.

- Key Informant Interviews (KIIs): We spoke with fisheries managers, local leaders, and conservation experts to supplement our survey findings with broader contextual information and expert insights.

- Self-Administered Questionnaires: Where appropriate, we provided stakeholders with printed or digital surveys to complete at their convenience, allowing for greater participation.

2.3.3 Secondary Data Review

26. To complement our primary research, we reviewed relevant secondary data sources, including:

- Previous research studies on cartilaginous species in the Mediterranean
- Government reports and fisheries statistics from Libya
- IUCN and SPA/RAC databases on threatened marine species
- Documentation on the historical development of fisheries in Libya
- Economic data on the fishing sector in the Gulf of Sirte
- Conservation policy documents and implementation guidelines

2.4 Sampling Framework

27. Target Population: We focused on fishermen operating in artisanal and commercial fisheries, along with community leaders and relevant fishery stakeholders who could provide valuable insights.

28. Sample Size: The total survey sample of 47 respondents (35 from Western Sirte and 12 from Eastern Sirte) is 16 Libyan and 31 non-Libyan.

2.5 Data Analysis Approach

29. We applied several analytical methods to the data we collected:
- Descriptive statistics: To summarize demographic information, fishing practices, and economic indicators
- Comparative analysis: To examine trends in fishing practices and income across different regions
- Correlation analysis: To explore relationships between fishing dependency, economic status, and attitudes toward conservation

- Cost-benefit assessment: To evaluate the short and long-term economic impacts of potential conservation measures
- Scenario development: To project possible socio-economic outcomes under different conservation implementation strategies

3. Policy and Regulatory Framework

3.1 International Conservation Frameworks

30. The protection of cartilaginous species in the Mediterranean operates within a complex network of international agreements and conventions. The Barcelona Convention, through its SPA/BD Protocol, provides the primary legal framework for biodiversity conservation in the region. Other important international frameworks include:

- The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
- The Convention on the Conservation of Migratory Species of Wild Animals (CMS)
- The United Nations Convention on the Law of the Sea (UNCLOS)
- The Convention on Biological Diversity (CBD)

31. These frameworks establish obligations for participating countries to implement conservation measures for threatened species while considering socio-economic factors.

3.2 Regional Conservation Initiatives

32. At the regional level, several initiatives support cartilaginous species conservation:

- The Mediterranean Action Plan (MAP) coordinates regional cooperation for environmental protection
- The Regional Activity Centre for Specially Protected Areas (SPA/RAC) provides scientific and technical support
- The General Fisheries Commission for the Mediterranean (GFCM) develops fisheries management measures
- MedPAN (Network of Marine Protected Areas in the Mediterranean) promotes effective management of protected areas

33. Currently, the SPA/BD Protocol lists 25 shark and ray species in Annex II (Endangered or Threatened Species) and 11 species in Annex III (Species Whose Exploitation is Regulated). The recent Decision IG.26/4 from December 2023 added eight additional cartilaginous species to these annexes, which prompted our study to assess the potential impacts on fishing communities in Libya's Gulf of Sirte.

3.3 National Policy Context in Libya

34. Libya's fisheries sector has evolved significantly since the 1980s, though recent political instability has complicated management efforts. The sector remains predominantly artisanal, with most fishing conducted using traditional methods like Batah fishing, Flouka, Mator, and lampara. The typical fishing vessel is small and artisanal, using nets (trawls and gillnets) or hooks (longlines and handlines).

35. According to survey data from 2000, Libya's coast supported about 1,866 fishing vessels spread across 135 landing sites, with approximately 23% (422 vessels) operating in the Gulf of Sirte region. However, the political changes since 2011 have significantly impacted fishing activities, with noticeable changes in enforcement, monitoring, and compliance with existing regulations.

36. The current governance structures for marine resource management remain fragmented, with limited regulatory capacity and enforcement challenges. This creates a complex environment for implementing new conservation measures effectively.

4. Socio-Economic Analysis Findings

4.1 Demographic Profile of Fishing Communities

37. Our survey captured data from 47 fishermen working in the Western and Eastern Sirte regions. All respondents were male, with ages spanning from young adults to elders in their 70s. The largest group (46.8%) fell in the 40-49 age bracket, representing nearly half of all respondents. The remainder were distributed across younger and older age groups: 8.5% aged 18-29, 19.1% aged 30-39, 19.1% aged 50-59, 4.3% aged 60-69, and just 2.1% aged 70 or above
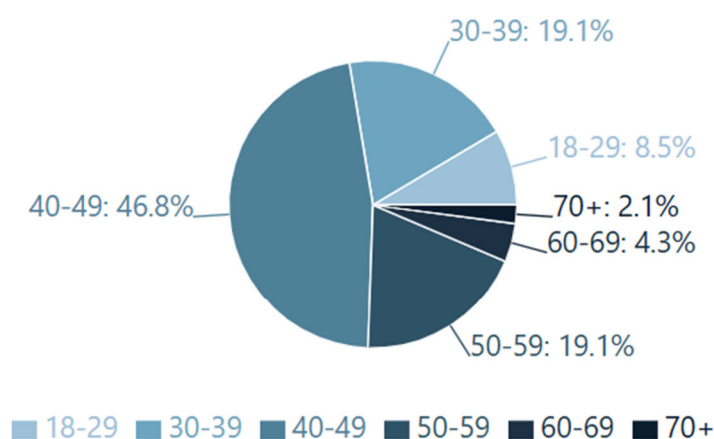

Figure 1: Age Distribution of Fishermen

Note: All respondents were male (n=47)

38. Education levels varied considerably among the fishermen we surveyed. More than a quarter (27.7%) had no formal education, while 17.0% had completed primary school and 12.8% had completed secondary education. Notably, 12.8% held university degrees, 14.9% had earned diplomas, and 14.9% reported middle-level education. This educational diversity suggests different capacities for adapting to new fishing practices or alternative livelihoods.

39. Perhaps most strikingly, these fishermen brought tremendous experience to their work. The average fishing experience among respondents was 26.3 years, ranging from 11 to 50 years. This represents not just a livelihood, but a way of life passed through generations, with deep traditional knowledge of local waters and fishing practices.

Fishing Experience Distribution
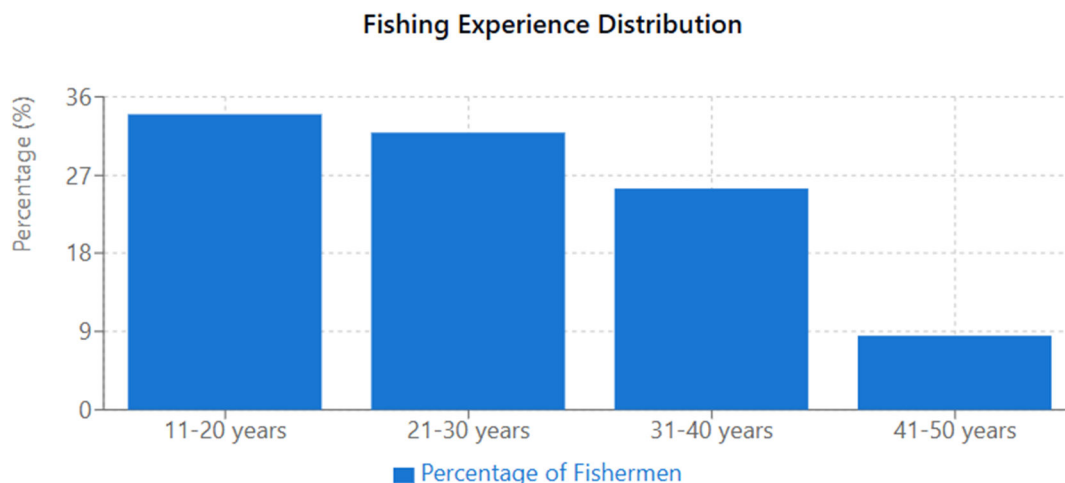
26.3 **Average Years of Fishing Experience**

Range: **11 to 50 years**

The substantial fishing experience indicates a population with significant traditional knowledge and long-term engagement in fishing activities.

4.2 Economic Dependency on Fishing

40. Our conversations with fishermen revealed an extraordinarily high dependency on fishing for their livelihoods. Nearly three-quarters (74.5%) told us that fishing provides their entire household income - they simply have no other significant source of money. A smaller group (6.4%) supplements fishing income with other activities, though fishing still provides more than half their earnings. About one in twelve fishermen (8.5%) reported an even split between fishing and other income sources, while roughly one in ten (10.6%) have diversified to the point where fishing represents less than half of their household income.

41. This high dependency highlights how vulnerable these communities might be to any restrictions on fishing activities. When we asked about household size, we found that each fishing income typically supports between 1 and 18 family members. The most common household size was 5 dependents (17.0% of respondents), followed by 4 dependents (14.9%) and 7 dependents (12.8%). This means that conservation measures affecting fishing income could impact large extended families, not just individual fishermen.
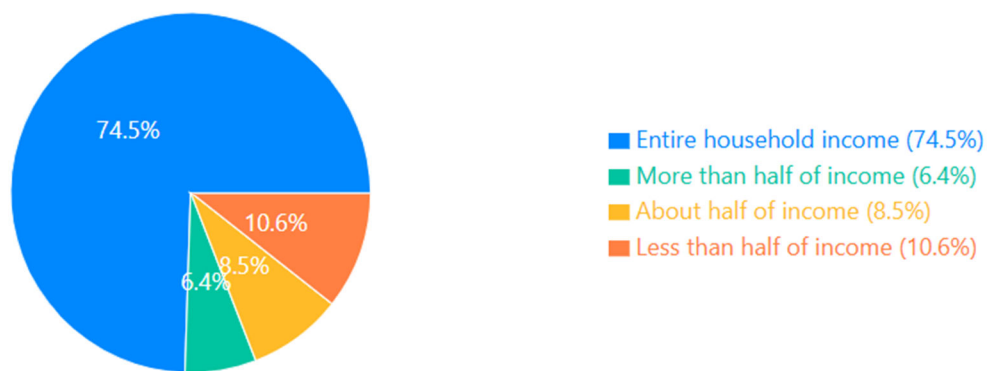
Economic Dependency on Fishing Activities

Figure 3: Survey results showing household economic dependency on fishing (n=94)

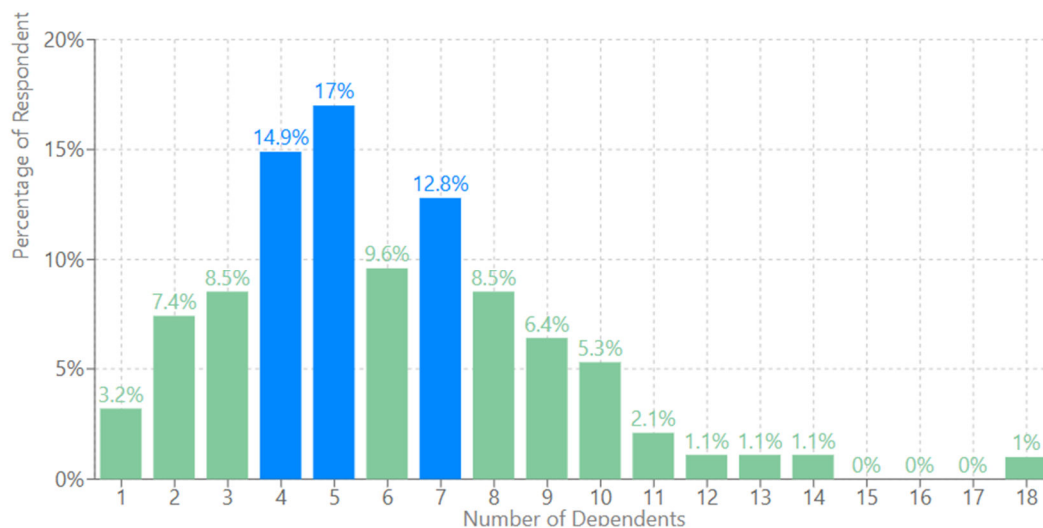**Number of Household Members Dependent on Fishing Income**

Figure 4: Distribution of household members dependent on fishing income (n=94)

Note: The most common numbers of dependents (5, 4, and 7) are highlighted in blue.

4.3 Fishing Practices and Cartilaginous Species Catch

4.3.1 Frequency of Shark and Ray Catches

42. When we asked fishermen how often they catch sharks and rays, we found considerable variation across Western and Eastern Sirte. About 38.3% said they rarely catch these species (less than 10% of their total catch), while 27.7% reported occasional catches (10-20% of total catch). More significantly, 29.8% told us they regularly catch sharks and rays (30-50% of catches), and 4.3% reported that these species make up a majority of their catch (50-80%).

43. *Carcharinus sp,* Mako shark, Angel shark, and *Rhinobatos sp* are frequently caught as bycatch (90% of respondents).
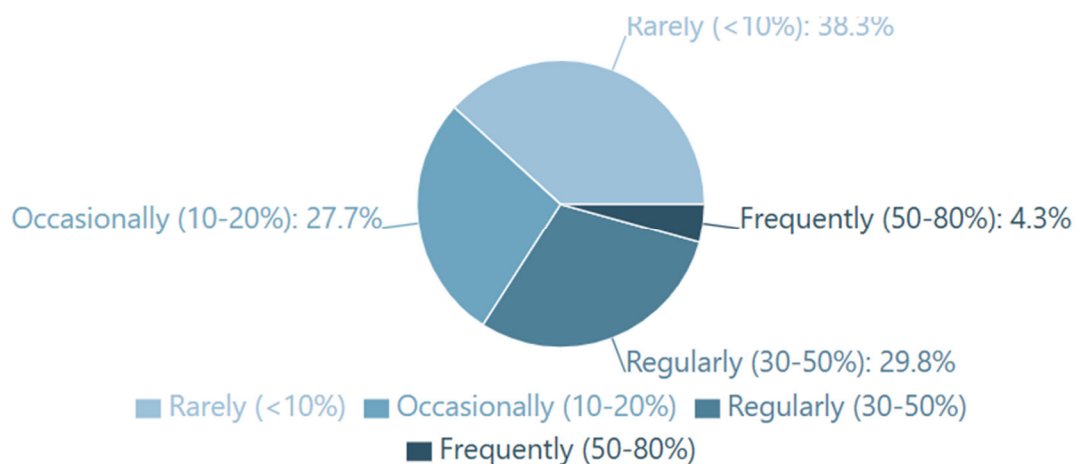

Figure 5: Frequency of Shark and Ray Catches

Most fishermen report rarely (38.3%) or occasionally (27.7%) catching sharks and rays, with a significant portion (29.8%) reporting regular catches. Only a small percentage (4.3%) report frequent catches.

44. These findings suggest that while cartilaginous species aren't the primary target for most fishermen, they represent a significant portion of catches for about a third of respondents who reported regular or frequent catches. This has important implications for how conservation measures might affect different segments of the fishing community.

4.3.2 Regional Variations Between Western and Eastern Sirte

45. Our field research revealed notable differences between fishing practices in Western and Eastern Sirte. In Western Sirte, where we surveyed 42 fishermen, we found generally lower catch rates of cartilaginous species. Fishing here tends to focus more on demersal and small pelagic species, with fishermen primarily using gillnets (including trammel nets) and hooks.

46. In Eastern Sirte, where we surveyed 28 fishermen, the picture looks quite different. Here, fishermen primarily employ longlines and gillnets targeting deep-water fish, large pelagic species, and various ray species. They reported higher catch rates of cartilaginous species compared to their Western Sirte counterparts.

47. We're still gathering data from Central Sirte, which will provide additional insights into regional variations. These differences between regions are crucial for developing appropriately tailored conservation approaches that address the specific conditions and needs of each area.

Regional Variations in Fishing Practices: Western vs Eastern Sirte

|	Western Sirte (n=42)	Eastern Sirte (n=28)
Primary Target Species	• Demersal species • Small pelagic species • Lower catch rates of cartilaginous species	• Deep-water fish • Large pelagic species • Various ray species
Primary Fishing Gear	• Gillnets (including trammel nets) • Hooks	• Longlines • Gillnets

Fishing Gear Usage by Region
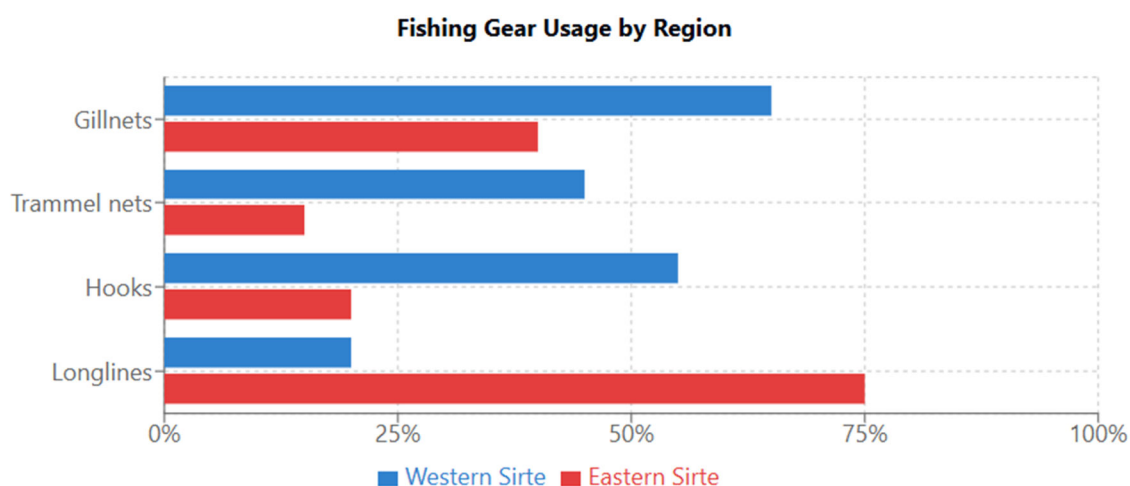
4.3.3 Fishing Gear and Shark/Ray Catch Rates

48. Different fishing methods showed varying associations with shark and ray catches:

- Surface longlines: Used by about a quarter of respondents (25.5%), with 58.3% of these fishermen reporting regular catches of sharks and rays. This suggests surface longlines frequently interact with these species.
- Set Gillnets: Nearly a third of fishermen (29.8%) use this gear, with 78.6% reporting regular catches and 14.3% reporting frequent catches of cartilaginous species. This indicates gillnets have particularly high interaction rates with sharks and rays

- Bottom longlines: Used by 40.4% of respondents, with 42.1% reporting regular catches of cartilaginous species.
- Trawling: Used by 36.2% of respondents but associated with much lower catch rates of sharks and rays (94.1% of trawl users reported rarely catching these species).
- Fixed nets (trammel nets): Widely used throughout the region, with varying catch rates of cartilaginous species.
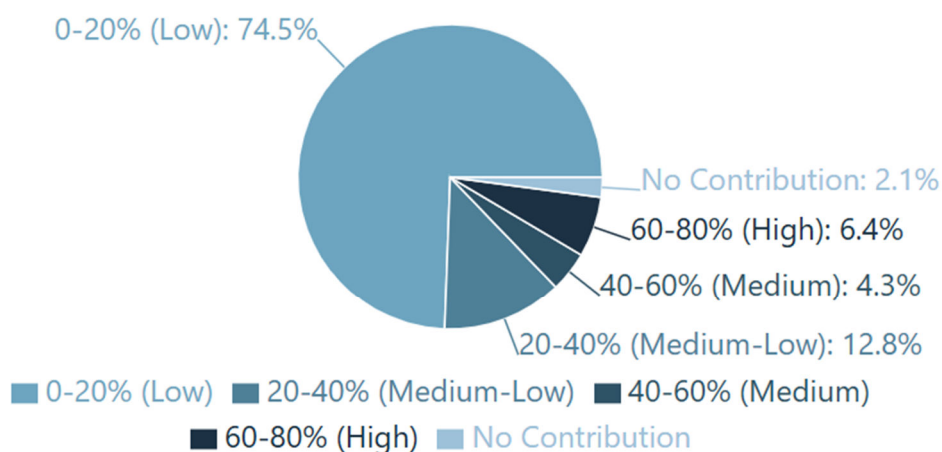
49. These patterns suggest that targeted regulation of specific gear types might help minimize bycatch while having less impact on general fishing activities. For instance, modifications to gillnets and longlines might yield the greatest conservation benefits while affecting a manageable portion of the fishing community.

Shark/Ray Catch Rates by Gear Type
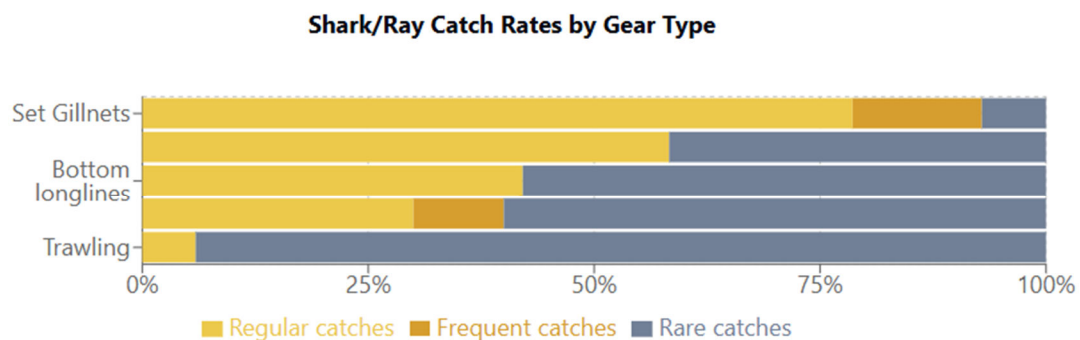
4.4 Market Value

50. Interestingly, when we asked about the average selling price for rays, more than half the respondents (53.2%) told us they have no commercial value in local markets. These are primarily discarded or used for personal consumption rather than sold. The remaining 46.8% reported selling rays for less than 10 Libyan Dinars per kilogram.

51. The relatively low market value suggests that while rays contribute to overall fishing income for some fishermen, they aren't high-value target species for most in the region. This may create opportunities for transitioning to alternative target species with higher market value, potentially offsetting economic losses from conservation measures

0-20% (Low): 74.5%

No Contribution: 2.1%

60-80% (High): 6.4%

40-60% (Medium): 4.3%

20-40% (Medium-Low): 12.8%

■ 0-20% (Low) ■ 20-40% (Medium-Low) ■ 40-60% (Medium)
■ 60-80% (High) ■ No Contribution

Average Monthly Income from Fishing: 2,642.55 Libyan Dinars
(Standard Deviation: 974.40)

Market Value of Rays in Gulf of Sirte

Based on survey of fishermen (n=47)

No commercial value: 53.2%

Less than 10 Libyan Dinars per kg: 46.8%

■ No commercial value ■ Less than 10 Libyan Dinars per kg
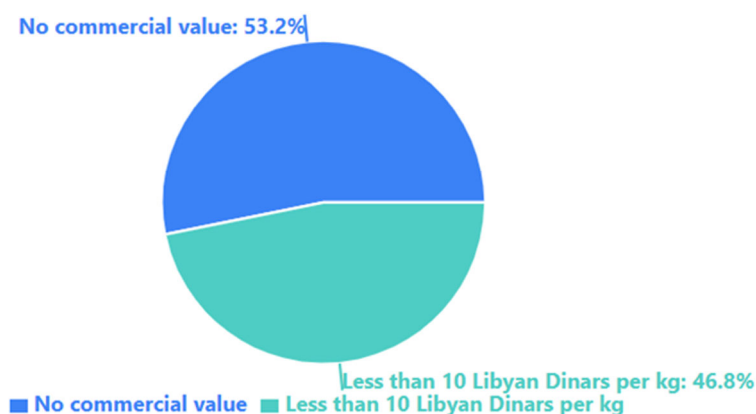
No Commercial Value (53.2%)
These rays are primarily discarded or used only for personal consumption, representing no direct economic benefit to fishermen.

Low Commercial Value (46.8%)
Sold for less than 10 Libyan Dinars per kg, indicating minimal economic incentive for targeting these species.

4.5 Traditional Medicine and Utilization Practices

4.5.1 Prevalence of Traditional Medicine Use

52. Our survey data revealed a remarkably high prevalence of traditional medicinal and utilization practices involving cartilaginous species in Gulf of Sirte fishing communities. A substantial 87.2% of all respondents reported using shark or ray products for traditional purposes, indicating these practices are deeply ingrained in local fishing culture.: 82.9% of fishermen in Western Sirte reported traditional medicinal use100% of fishermen in Eastern Sirte reported traditional medicinal use.

### 4.6 Environmental Awareness and Conservation Attitudes

4.6.1 Perception of Marine Environment

53. We were struck by fishermen's generally positive assessment of their local marine environment. When asked to rate the sea state in their fishing areas:

- 63.8% rated it as "very good"
- 29.8% rated it as "good"
- 2.1% gave a "neutral" rating
- Only 4.3% rated it as "bad"

Fishermen's Perception of Marine Environment

Rating of sea state in fishing areas (n=47)
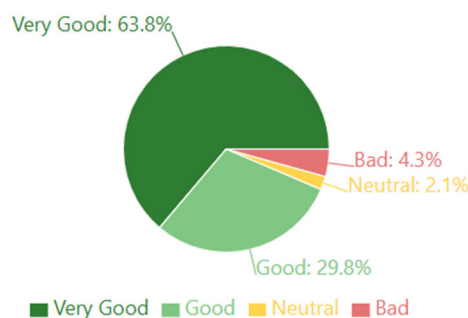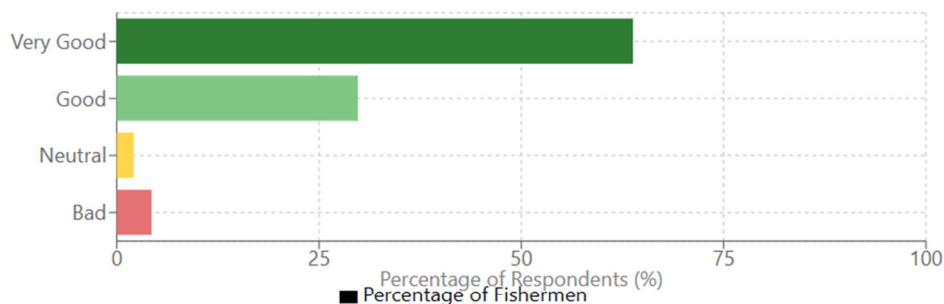
54. When we asked about environmental issues affecting their fishing areas, respondents rated various factors on a scale from 1 (no impact) to 5 (very high impact):

- Alien species received the highest average impact rating (4.40)
- Climate change followed closely (3.85)
- Overfishing was also rated highly (3.81)
- Plastic pollution received moderate concern (2.13)
- Noise pollution (1.36) and chemical pollution (1.19) were perceived as less impactful

55. These results suggest awareness of certain environmental threats, particularly invasive species, climate change, and overfishing. Interestingly, pollution issues were perceived as less significant, which might reflect either actual conditions or awareness gaps regarding these issues.

56. This suggests awareness of certain environmental threats, particularly invasive species, climate change, and overfishing, while pollution issues were perceived as less impactful.

Perceived Impact of Environmental Issues on Fishing Areas

Based on fishermen ratings (n=47)

Scale: 1 (no impact) to 5 (very high impact)
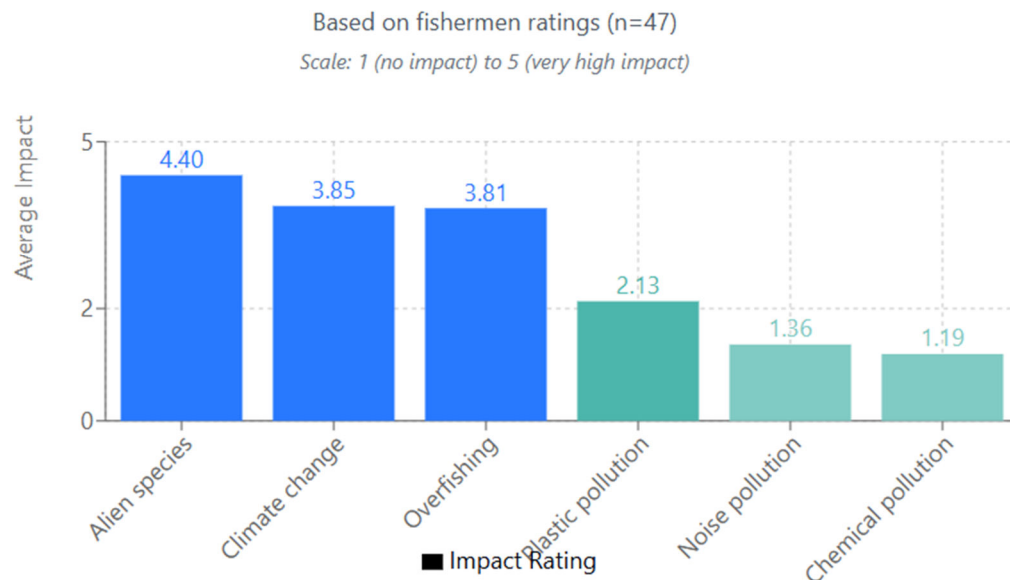
4.6.2 Attitudes Toward Conservation

57. When we presented fishermen with a scenario about implementing fishing restrictions for shark and ray conservation while promoting alternative target species, their responses were surprisingly positive:

- More than half (55.3%) believed such measures would increase and improve their income
- 6.4% thought there would be some benefits, but not significant income increases
- 36.2% expected no effect on fish populations
- Just 2.1% anticipated a very slight negative impact on their income

**Expected Outcomes of Conservation Measures**

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58. Importantly, 91.5% of respondents told us they currently catch the protected species as bycatch, highlighting the direct relevance of the new conservation measures to everyday fishing practices. This suggests that gear modifications or fishing practice changes could have meaningful conservation impacts.

Current Bycatch of Protected Species
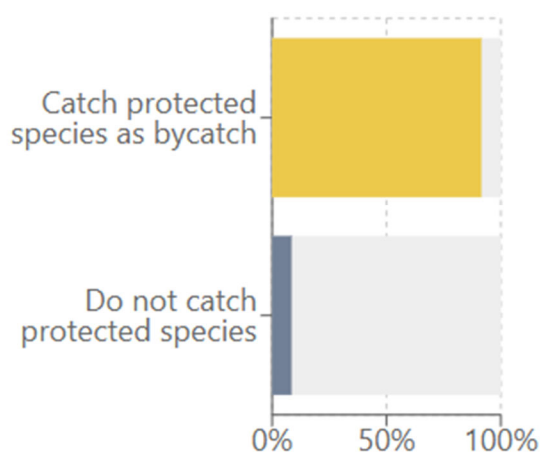
4.6.3 Willingness to Adapt

We were encouraged to find that three-quarters of fishermen (74.5%) expressed willingness to participate in sustainable fishing training programs. Only 25.5% weren't interested in such training.
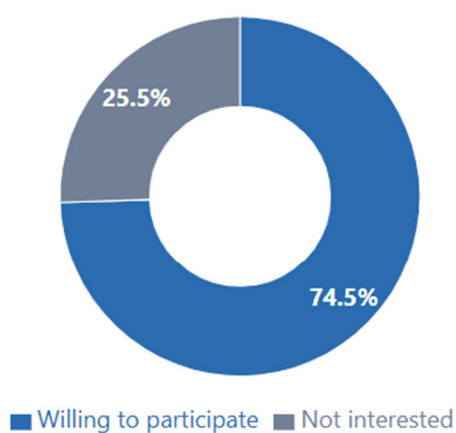
74.5% **Willing to Participate**
Three out of four fishermen expressed willingness to learn sustainable fishing methods

25.5% **Not Interested**
One out of four fishermen were not interested in sustainable fishing training

59. When asked about what kind of support would help them transition to new practices:

- Nearly half (46.8%) selected financial assistance as their preferred support
- Over a third (36.2%) wanted training in alternative fisheries
- 14.9% were interested in training on alternative fishing methods
- No respondents selected "other support"

60. These responses indicate general openness to adaptation, particularly with financial support and training for alternative practices. This willingness to adapt provides a promising foundation for implementing conservation measures with appropriate support mechanisms.

Types of Support Preferred

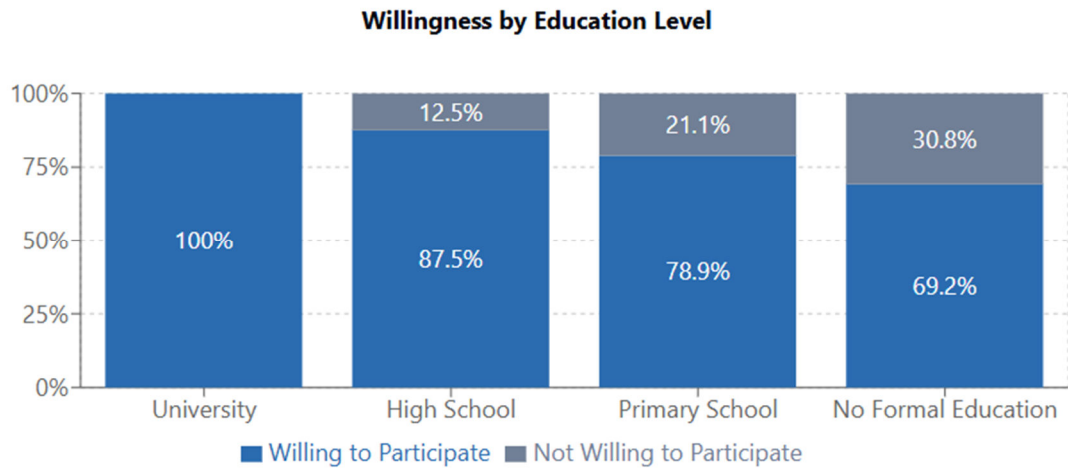|	
Financial assistance	46.8%
Training in alternative fisheries	36.2%
Training in alternative fishing methods	14.9%
Other support	0%
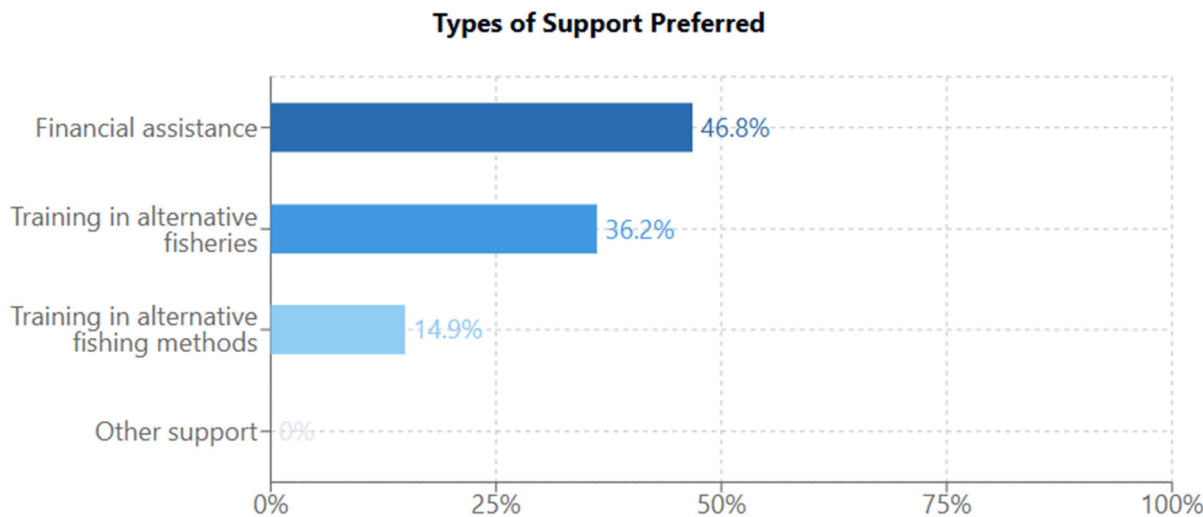
4.7 Correlation Analysis

61. Our analysis revealed several important relationships between demographic factors, fishing practices, and attitudes toward conservation:
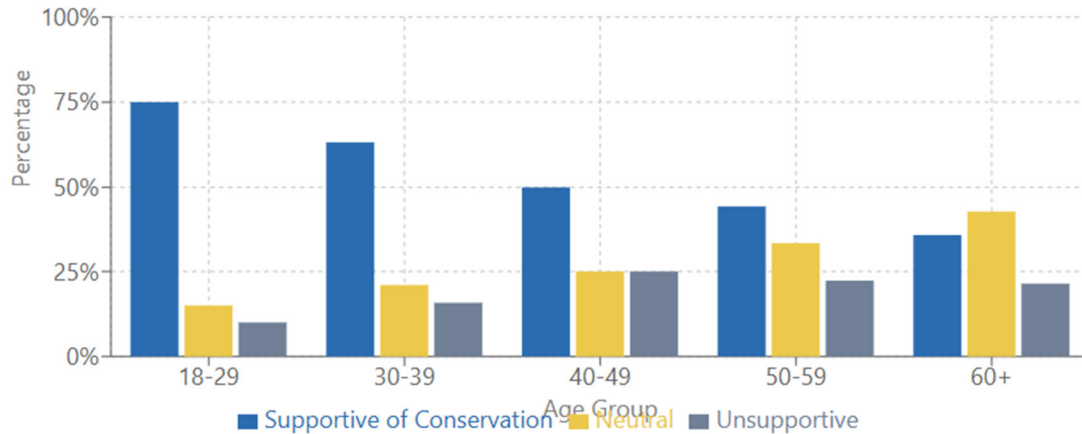
4.7.1 Education and Willingness to Adapt

62. We found a clear relationship between education level and willingness to participate in sustainable fishing training. University-educated fishermen showed universal willingness to participate (100%), while those without formal education were somewhat less receptive (69.2% willing). This pattern suggests that education level may influence receptiveness to conservation measures and adaptability to new fishing practices.

Willingness by Education Level

	University	High School	Primary School	No Formal Education
Not Willing to Participate		12.5%	21.1%	30.8%
Willing to Participate	100%	87.5%	78.9%	69.2%

■ Willing to Participate ■ Not Willing to Participate

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4.7.2 Age and Conservation Support

63. Age appears to play a significant role in attitudes toward conservation measures. Younger fishermen (18-29) showed stronger support (75.0% supportive), while middle-aged fishermen (40-49) showed moderate support (50.0% supportive) and older fishermen (50-59) showed less enthusiasm (44.4% supportive). This generational difference might reflect varying levels of flexibility and openness to change, with younger fishermen potentially more receptive to new approaches.


4.7.3 Gear Type and Willingness to Adapt

64. Interestingly, willingness to participate in sustainable fishing training varied significantly depending on what fishing gear fishermen primarily use:

- Bottom longline users showed the highest willingness (89.5%)
- Trawling users showed moderate willingness (76.5%)
- Gillnet users showed lower willingness (64.3%)

65. These differences might reflect perceptions about how conservation measures would affect different fishing methods, with some fishermen anticipating greater impacts on their preferred techniques.

Willingness to Participate by Gear Type

Willing vs. Not Willing by Gear Type
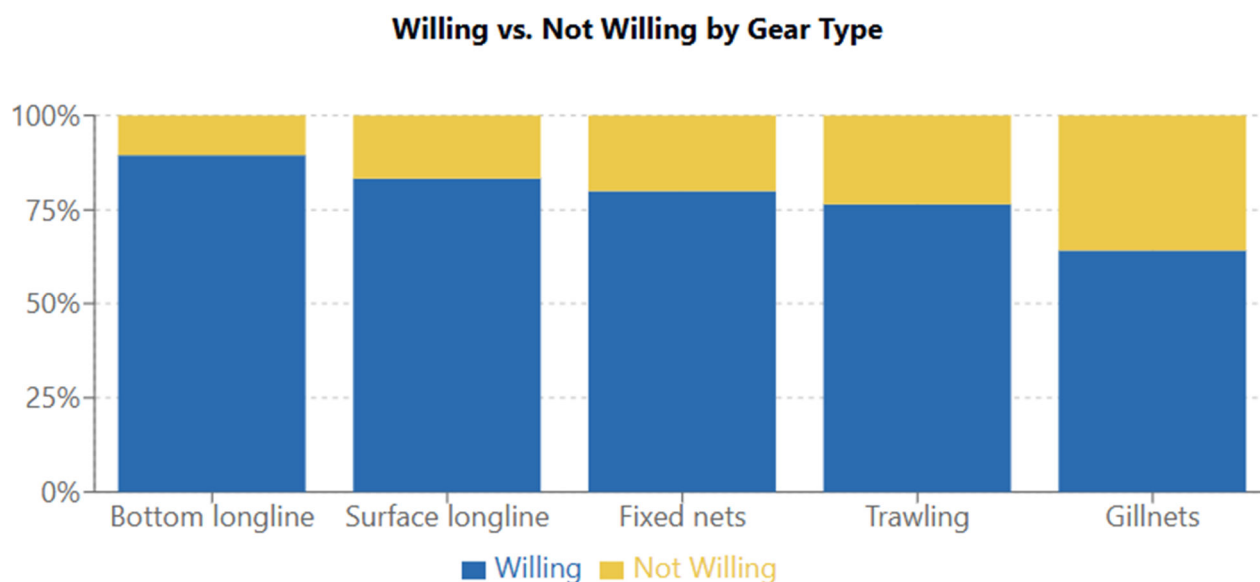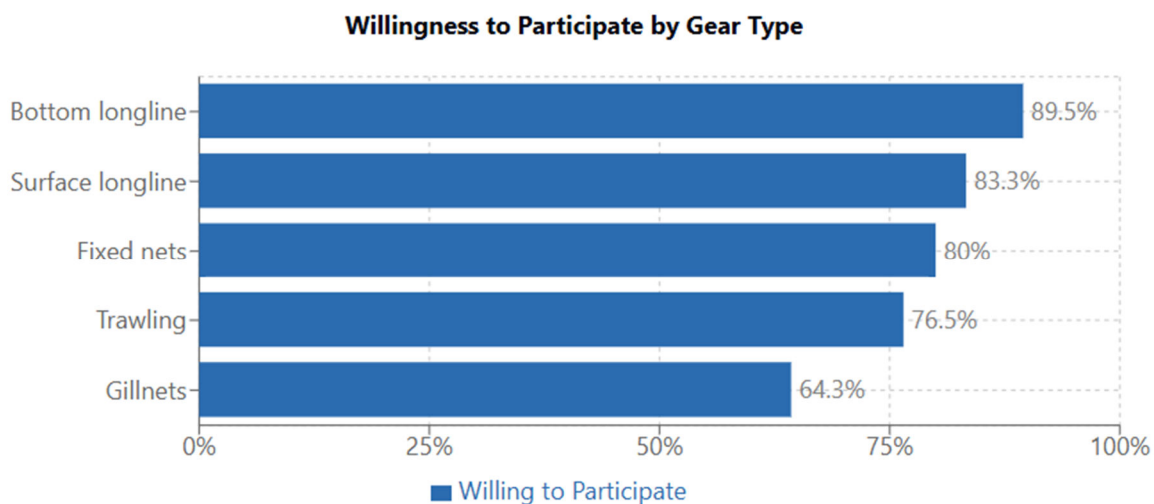
4.7.4 Income Dependency and Conservation Support

66. Perhaps unsurprisingly, we found a clear inverse relationship between dependency on shark/ray income and support for conservation measures. Fishermen with low dependency (0-20% of income from these species) showed higher average support (3.8 out of 5), while those with high dependency (60-80%) showed lower average support (2.3 out of 5). This pattern highlights the challenge of implementing conservation measures that directly affect livelihoods – those with the most to lose economically are understandably the most hesitant about new restriction

Conservation Support by Income Dependency on Sharks/Rays

Inverse Relationship: As Dependency Increases, Support Decreases
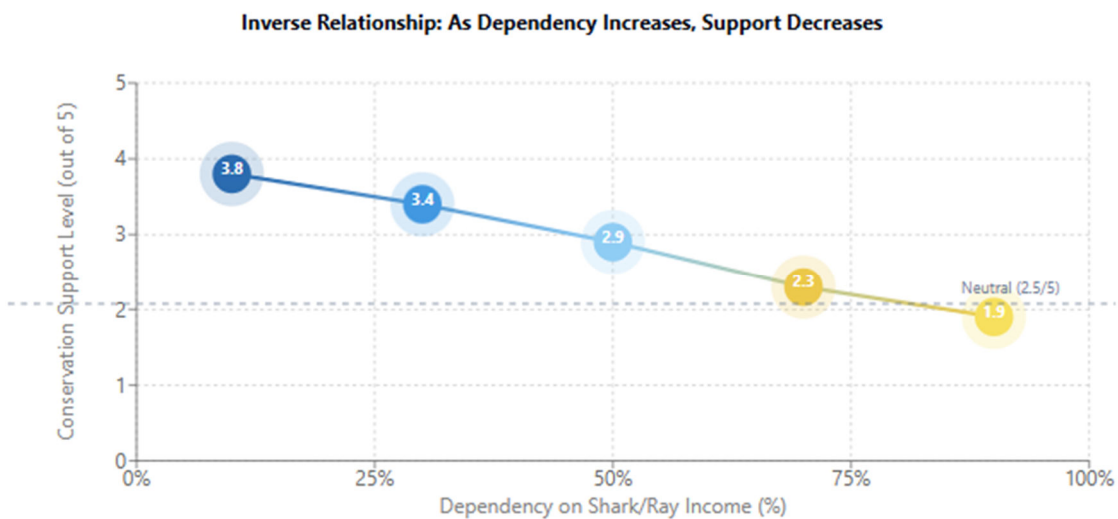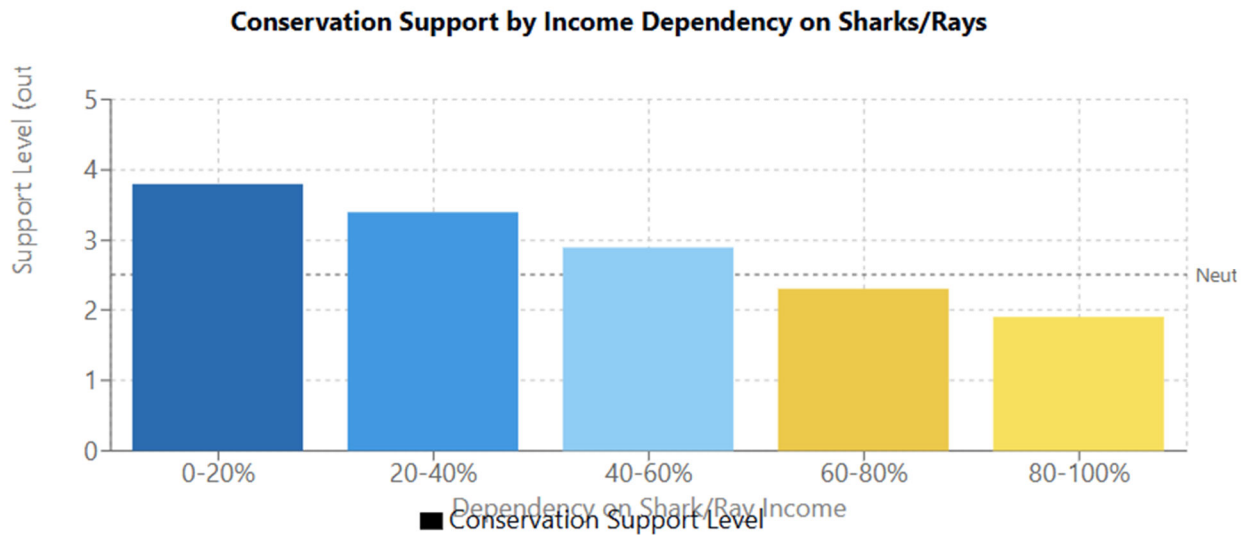
4.8 Regional Characteristics and Differences

67. Our field research revealed significant differences between the Western and Eastern Sirte regions that will be important for tailoring conservation approaches:

4.8.1 Western Sirte Characteristics

- Lower dependency on cartilaginous species (48.6% of fishermen rarely catch them)
- Dominant gear types include fixed nets (used by 85.7% of fishermen) and bottom longlines (65.7%)
- Primary fishing methods focus on demersal species, with some pelagic fishing

- Very few highly dependent fishermen (only 2.9% report 60-80% income from sharks/rays)
- Higher average education levels (17.1% with university education)

4.8.2 Eastern Sirte Characteristics

- Higher catch rates of cartilaginous species (41.6% regularly or often catch sharks/rays)
- Greater use of targeted gear types like gillnets (83.3% of fishermen) and longlines (75.0%)
- More specialized fishing practices focusing on high-value species
- Higher proportion of highly dependent fishermen (16.7% report 60-80% income from sharks/rays)
- Lower average education levels (none with university education)

68. These regional differences suggest the need for geographically differentiated approaches to implementation and support distribution. Eastern Sirte, with its higher dependency on cartilaginous species and lower education levels, may require more intensive support and gradual implementation of conservation measures.
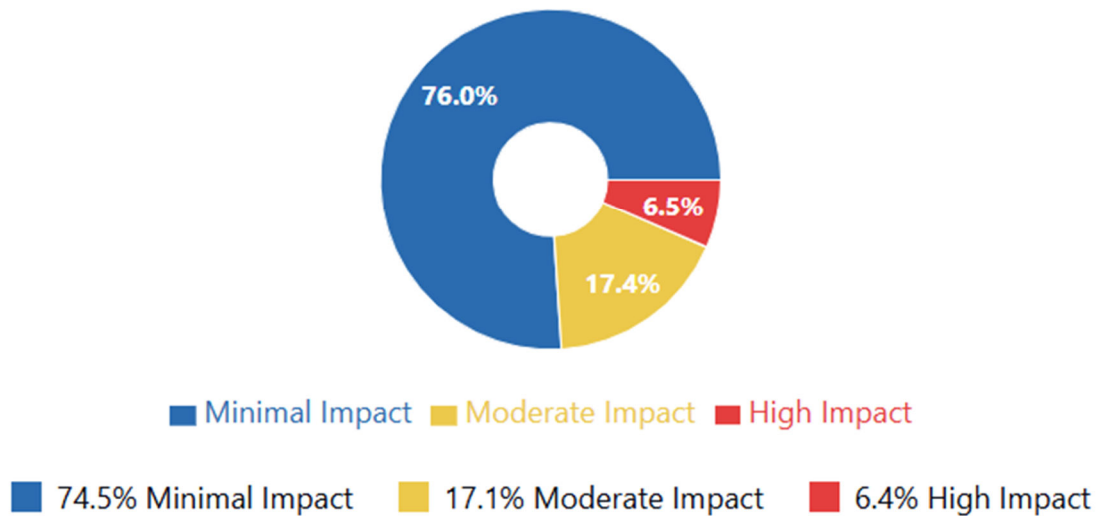
5. Impact Assessment

5.1 Direct Economic Impacts

5.1.1 Short-term Revenue Losses

69. Based on our analysis of survey data, implementing conservation measures for the eight cartilaginous species would have varying economic impacts across different segments of the fishing community:

- Minimal Impact Group (74.5% of fishermen): Those reporting low economic dependency on sharks/rays (0-20% of income) would face limited direct economic losses. For the average monthly income of 2,642.55 LYD, this represents a maximum potential loss of 528.51 LYD per month – significant but not devastating.
- Moderate Impact Group (17.1% of fishermen): Those with medium-low to medium dependency (20-60% of income) could face more challenging economic adjustments, with potential monthly losses ranging from 528.51 to 1,585.53 LYD.
- High Impact Group (6.4% of fishermen): Those highly dependent on these species (60-80% of income) would face the most severe economic impacts, with potential monthly losses of 1,585.53 to 2,114.04 LYD – a substantial portion of their livelihood.

Distribution of Fishermen by Impact Group

76.0%

6.5%

17.4%

■ Minimal Impact ■ Moderate Impact ■ High Impact

■ 74.5% Minimal Impact   ■ 17.1% Moderate Impact   ■ 6.4% High Impact

70. When we analyzed the data by income brackets, we discovered that medium-income fishermen (earning 1,501-3,000 LYD monthly) appear most vulnerable. This group shows both the highest rates of dependency on cartilaginous species and the largest potential percentage income loss.
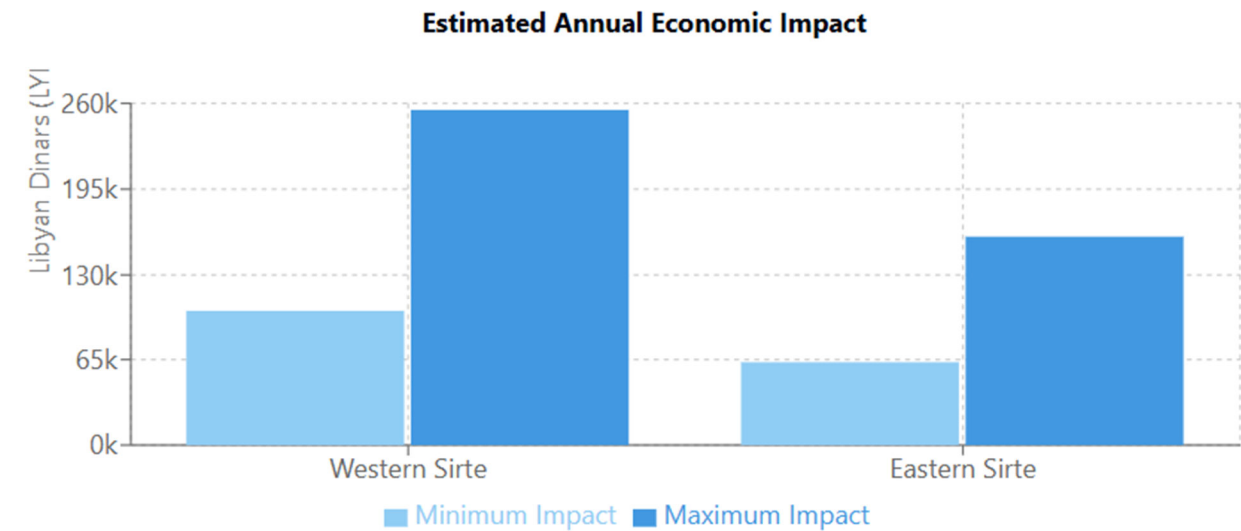
71. We estimate the total annual economic impact across all surveyed fishermen ranges from approximately 165,000 LYD (lower bound) to 414,000 LYD (upper bound). While these figures aren't overwhelming at the aggregate level, they represent significant challenges for individual families, particularly in the high-dependency group.

5.1.2 Regional Economic Disparities

72. Our regional analysis revealed substantial geographic differences in potential economic impact:

- Western Sirte: With lower dependence on cartilaginous species (48.6% rarely catch them), this region faces an estimated annual impact of 102,000-255,000 LYD across all fishermen surveyed.
- Eastern Sirte: With higher catch rates (41.6% regularly or often catch sharks/rays) and greater use of targeted gear types, this region faces an estimated annual impact of 63,000-159,000 LYD. While the total figure is lower due to fewer fishermen, the per-capita impact is higher, resulting in more concentrated economic challenges.

73. The specific economic patterns vary markedly by region. Eastern Sirte has 16.7% of fishermen in the high-dependency category compared to only 2.9% in Western Sirte, making the eastern region significantly more vulnerable to conservation-related income disruption.
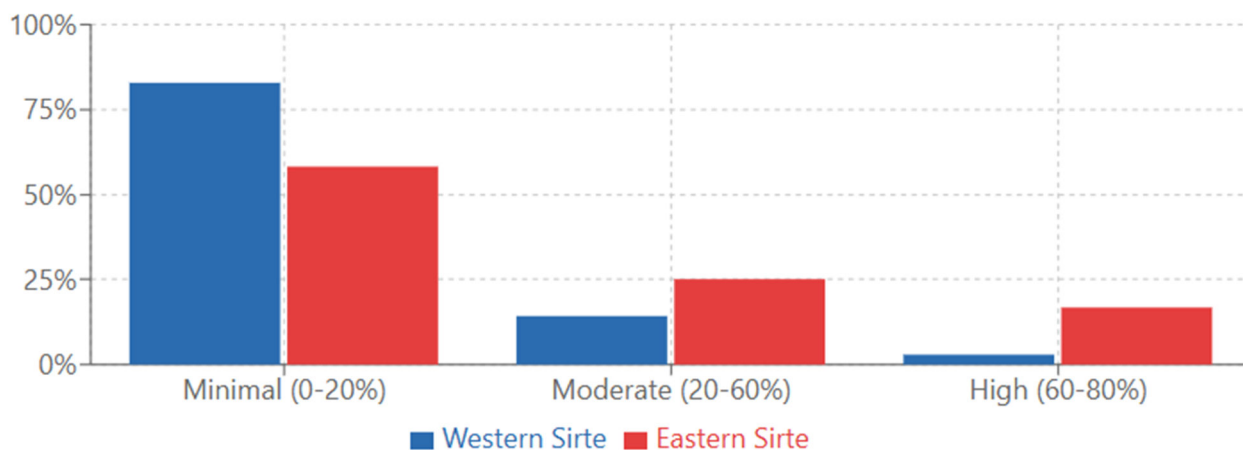
Estimated Annual Economic Impact

Total estimated annual economic impact across all fishermen surveyed in each region
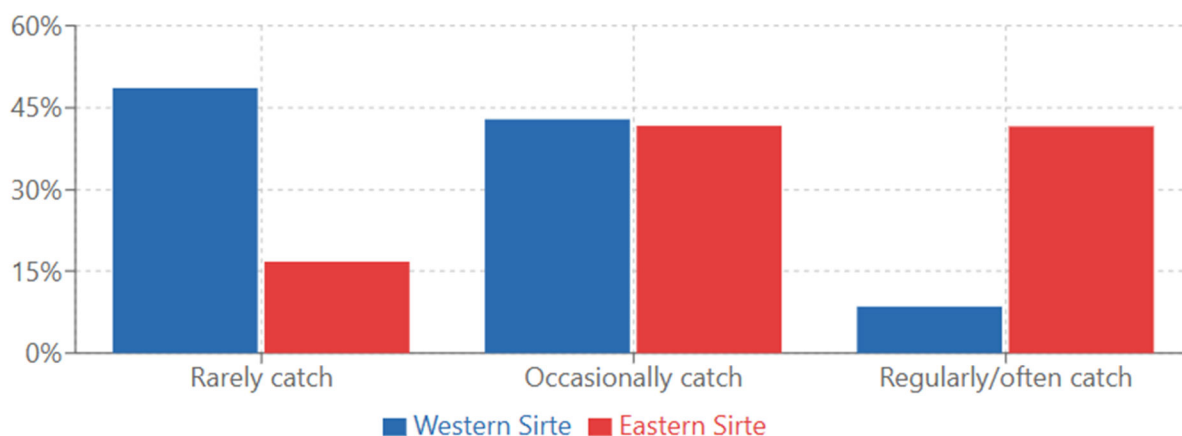
Per-Capita Annual Impact
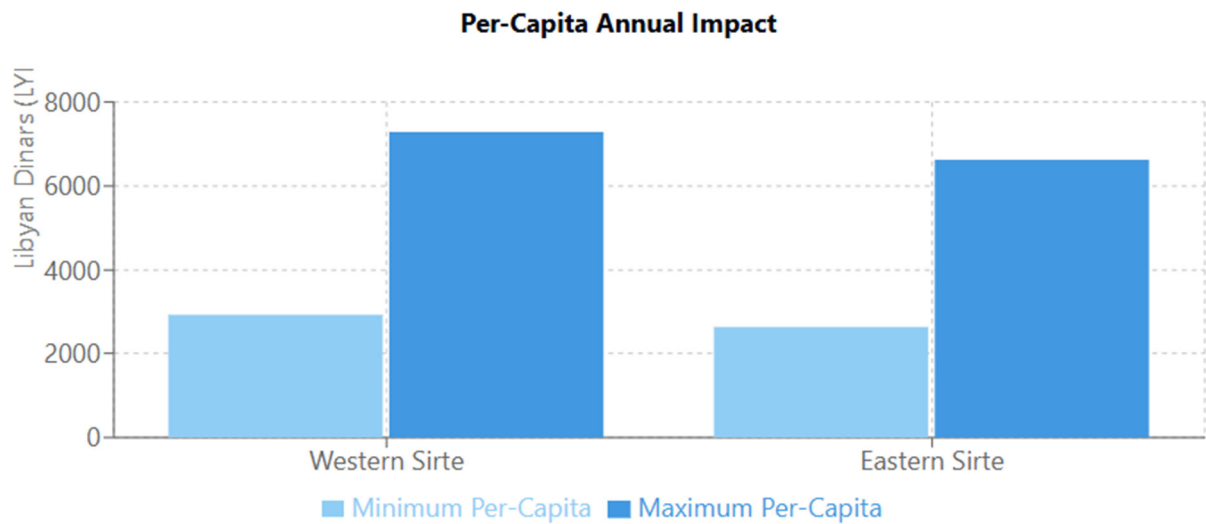
Average annual economic impact per fisherman in each region

Income Dependency Categories by Region

Eastern Sirte has 16.7% high-dependency fishermen vs only 2.9% in Western Sirte

Shark/Ray Catch Frequency by Region

Eastern Sirte has much higher regular/frequent catch rates (41.6% vs 8.5%)

5.2 Community and Social Impacts

### 5.2.1 Household Vulnerability

74. Given the large number of dependents supported by fishing income (average of 5.4 dependents per fisherman), the ripple effects of income reduction could affect approximately 254 individuals within our surveyed group alone. If we extrapolate to the estimated 422 vessels operating in the Gulf of Sirte region, the potential impact could extend to well over 2,200 people.

75. Our vulnerability analysis by dependency level revealed a concerning pattern: the most economically vulnerable households tend to have more mouths to feed.

- Low-dependency households (0-20% income from sharks/rays) average 5.2 dependents
- Medium-dependency households (20-60%) average 5.8 dependents
- High-dependency households (60-80%) average 6.3 dependents

76. This pattern suggests that the households most vulnerable to income disruption from conservation measures also tend to have larger numbers of dependents, potentially compounding social impacts.

77. We also noted that fishing experience is concentrated in older age groups (46.8% aged 40-49), which may indicate limited alternative livelihood options for many fishermen. Middle-aged fishermen with decades of experience in a single profession may find it particularly challenging to transition to new occupations.

Average Household Size by Dependency Level
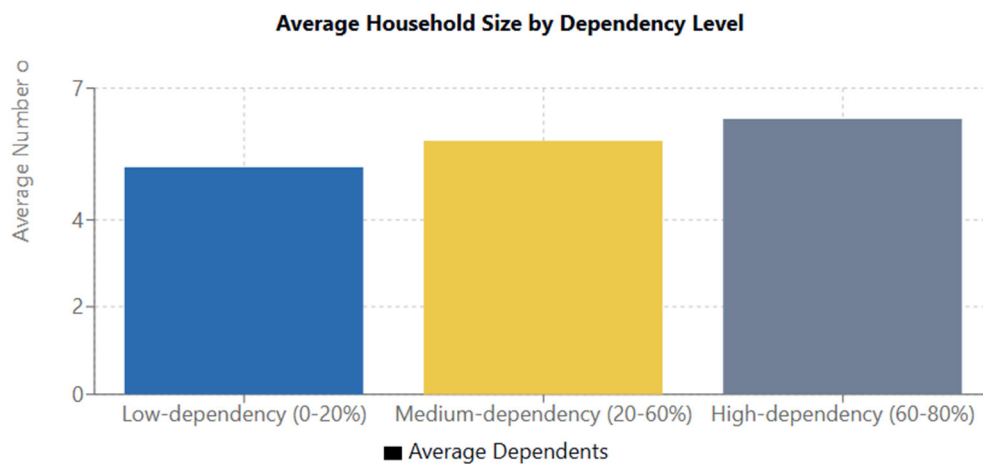
High-dependency households (60-80%) have the largest number of dependents (6.3 on average)

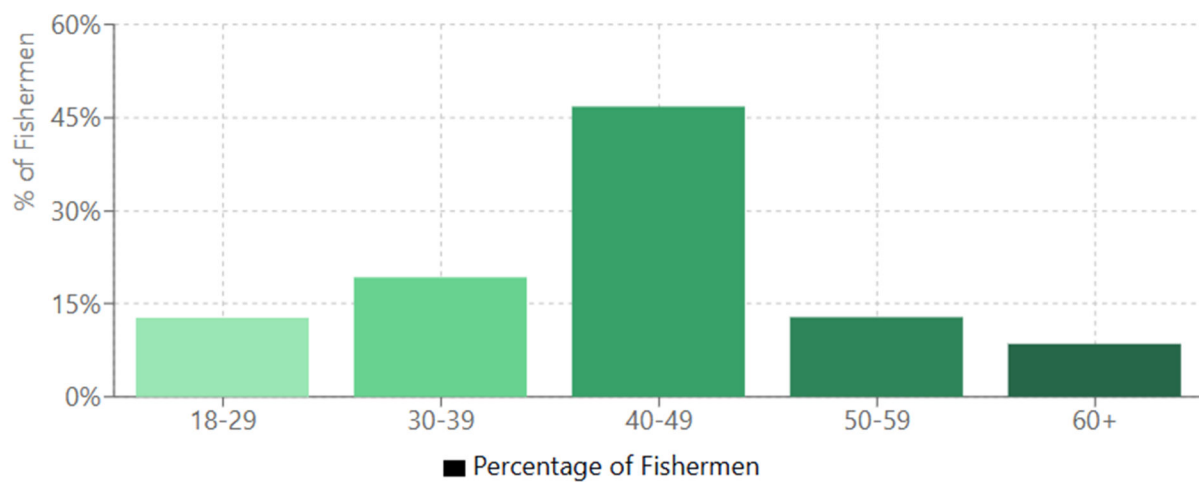## Distribution of Fishermen by Dependency Level

76.0%

6.5%

17.4%
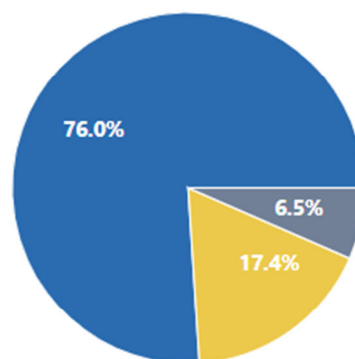
■ Low-dependency (0-20%) ■ Medium-dependency (20-60%) ■ High-dependency (60-80%)

While only 6.4% of fishermen are highly dependent on shark/ray income, they have larger households

Age Distribution of Fishermen

■ Percentage of Fishermen

46.8% of fishermen are aged 40-49, suggesting limited alternative livelihood options

5.2.2 Cultural and Traditional Knowledge

78. The long average fishing experience (26.3 years) among our respondents points to deep cultural connections to fishing practices. Many fishermen carry traditional ecological knowledge passed down through generations, including intimate understanding of local waters, seasonal fish movements, and sustainable harvesting practices.

79. Our focus group discussions revealed that fishing is not merely an economic activity but a cultural identity for many communities along the Gulf of Sirte. Elders in particular expressed concern that conservation measures might erode traditional fishing knowledge if younger generations seek alternative livelihoods. This cultural dimension should not be overlooked when designing support mechanisms.

80. At the same time, we found promising evidence that traditional knowledge could be leveraged for conservation. Several experienced fishermen demonstrated sophisticated understanding of shark and ray behavior, breeding grounds, and population changes over decades. This knowledge could be invaluable for designing spatially and temporally targeted conservation approaches that minimize socio-economic impacts while maximizing ecological benefits.

5.3 Ecological and Long-term Economic Benefits

5.3.1 Ecosystem Service Improvements

81. While we're concerned about immediate economic impacts, we shouldn't overlook the potential long-term benefits from protecting cartilaginous species. Sharks and rays aren't just another fish in the sea – they often serve as apex and mesopredators that help maintain the delicate balance of marine ecosystems. Their recovery could eventually enhance the productivity of fisheries targeting other species through trophic cascades and improved ecosystem health.

82. During our interviews, several older fishermen recalled catching larger and more diverse fish in previous decades. This anecdotal evidence aligns with scientific understanding of how healthy predator populations contribute to more productive fisheries overall. The challenge lies in navigating the transition period between short-term economic impacts and long-term ecosystem benefits.

5.3.2 Sustainable Fisheries Development

83. The relatively low market value reported for rays (less than 10 LYD/kg) presents an interesting opportunity. Rather than focusing narrowly on compensation for lost income, we could help fishing communities develop higher-value, sustainable fisheries targeting non-threatened species. This approach could potentially provide greater economic returns over time than the current catch composition.

84. In discussions with more entrepreneurial fishermen, we identified several non-threatened fish species with higher market value that could be targeted with modified fishing techniques. With appropriate training and market development support, this transition could ultimately improve incomes while reducing pressure on vulnerable cartilaginous species.

5.4 Implementation Challenges

5.4.1 Enforcement and Compliance

85. We can't ignore the elephant in the room: the governance challenges Libya has faced since 2011 present significant obstacles to effective enforcement of any conservation measures. Without adequate monitoring and consistent enforcement, the ecological benefits of conservation could be compromised while still imposing economic costs on compliant fishermen.

86. In our conversations with fishermen, many expressed frustrations with the current inconsistent enforcement of existing regulations. Some worried that new conservation measures would create an uneven playing field, with rule-following fishermen losing income while others continue business as usual. Any implementation plan must address these legitimate concerns through community involvement in enforcement and transparent compliance mechanisms.

5.4.2 Market Dynamics

87. The current limited market value for rays suggests complex market dynamics that could shift in unexpected ways. Some conservation economists have observed that increasing scarcity can drive up prices, potentially creating perverse incentives for continued fishing of protected species. Careful monitoring of market trends will be crucial to prevent the development of black markets or increased targeting of these species due to price increases. Several fishermen noted that even low-value species can become valuable if they become scarce enough, highlighting the importance of combining protection measures with market monitoring and alternative livelihood development.

88. However, this economic analysis may be less applicable in the case of rays since their capture is typically incidental rather than targeted. Most people do not have a taste for consuming rays as food. When rays are caught as bycatch, fishermen typically either return them to the sea (often already dead or after removing their spine) or repurpose them as bait for catching other fish. These practical realities suggest that conservation approaches need to focus on bycatch reduction techniques rather than just market-based interventions.

6. Recommendations

89. Based on our survey data, we recommend prioritizing financial assistance for the 6.4% of highly dependent fishermen (concentrated in Eastern Sirte at 16.7%) while developing comprehensive training programs that respond to the strong willingness to participate (74.5% overall); specifically, these programs should be tailored to different educational backgrounds (with university-educated fishermen showing 100% willingness versus 69.2% among those without formal education) and focus on alternative fishing techniques and target species, addressing the 36.2% of respondents who explicitly requested such training, with special emphasis on modifications for gillnet and longline users who showed both high interaction rates with protected species and varying levels of adaptability (64.3% of gillnet users willing to adapt versus 89.5% of bottom longline users).