REFERENCES


Osman, M.O.M. 2009. *Fishing technology*. Khartoum, currency printing press Environment and Natural Resources Research Institute, the National Centre Research, Khartoum.


Annexure A

1. The dynamic deterrence with frequency of violation specification

By taking into consideration the definitions of illegal profits \( \pi(m, c, p_a Q_m E_m s, x) = m(p_a Q_m (E_m s) - c(E_m)) = m(p_a Q_m - c(E_m)) \) in the first period and the legal profit \( \pi(n, b, p_n Q_n E_n, x) = n(p_n Q_n (E_n x) - b(E_n)) = n(p_n Q_n - b(E_n)) \) in the second period, Illegal profits will be denoted by \( \pi(m) \) and the legal profit, by \( \pi(n) \) and also

\[ v(p_a Q_m, E_m, s, c, m, n, b, x, Q_n, E_n, p_n) \] by \( v(.) \) and \( Pr(m) \) by \( B \) for simplicity; then the value function for each violator is:

\[
v(.) = \int_0^\infty e^{-\delta t} (\pi(m) + \pi(n)) (1 - G(t)) + \pi(n)G(t) - RFg(t)dt \quad (1.1)
\]

\[
v(.) = \int_0^\infty e^{-\delta t} (\pi(m) + \pi(n) - \pi(m)G(t)) - RFg(t)dt \quad (1.2)
\]

The values of the density and cumulative functions are derived in equation (4.11) in the text (chapter 4) as follow: \( G(t) = 1 - e^{-Bt} \) and \( g(t) = B e^{Bt} \) and \( B = Pr(m) \). Substituting these values in (1.2) above gives:

\[
v(.) = \int_0^\infty e^{-\delta t} \pi(m) + \pi(n) - (\pi(m)(1 - e^{-Bt})) - RFBe^{-Bt} dt \quad (1.3)
\]

\[
+ \pi(m) \text{ and } - \pi(m) \text{ will simplify as follow:}
\]

\[
v(.) = \int_0^\infty e^{-\delta t} \pi(n) + \pi(m)e^{-Bt} - RFBe^{-Bt} dt \quad (1.4)
\]

\[
v(.) = \int_0^\infty e^{-\delta t} \pi(n) + (\pi(m) - RFBe^{-Bt}) dt \quad (1.5)
\]

\[
\pi(m) \frac{e^{-(Pr+\delta)t}}{-(Pr+\delta)} \Bigg|_{t=0}^{\rightarrow \infty} - FRPr \frac{e^{-(Pr+\delta)t}}{-(Pr+\delta)} \Bigg|_{t=0}^{\rightarrow \infty} + \pi(n) \frac{e^{-\delta t}}{-\delta} \Bigg|_{t=0}^{\rightarrow \infty}
\]

\[
v(.) = \frac{\pi_m - RFB}{B+\delta} \quad (1.6)
\]
Which is in the expanded form (substituting for B and \(\pi\)) is:

\[
v(. ) = \frac{(m p_a Q_m (E_m s) - m c(E_m) - RFPr(m))}{\delta + \Pr(m)} + \frac{n p_n Q_n (E_n x) - n b(E_n)}{\delta}
\] (1.7)

This will give the value function for each violator as:

\[
v(. ) = \frac{(m p_a Q_m (E_m s) - RFPr(m))}{\delta + \Pr(m)}
\] (1.8)

The second term in equation 1.7 is excluded since doesn’t include \((m)\)

2. Derivation of comparative static’s properties

Invoking the Implicit Function Theorem for function \(K (m^*(\alpha), \alpha)\), where \(\alpha\) is a vector of the set of arguments in the model and \(m\) is at its optimal level \(m^*\) (hence omitting the * for simplicity), the following holds for each argument \(\alpha_j\) at the optimum (Chiang, 1984):

\[
\frac{dk}{d\alpha} = \frac{dk}{dm} \frac{dm}{d\alpha} + \frac{dk}{d\alpha} = 0 \text{ such that } \frac{dm}{d\alpha} = -\frac{dk}{dm}
\] (2.1)

Employing the first-order conditions’ equation (2.1), which determine the optimal frequency of violation (i.e. \(m^*\)), we can derive the comparative static’ (CS) properties of \(m^*\) with respect to its parameters \(p_a, F, R, C, b, Pr, \delta\). Let \(K\) be

\[
K = \frac{dV}{dm} = \frac{[p_a Q_m (\cdot) - c(E_m) - RFPr_m](\delta + \Pr(m)) - Pr_m[m p_a Q_m (\cdot) - m c(E_m) - RFPr(m)]}{(\delta + \Pr(m))^2} = 0
\] (2.2)

The first derivative of equation (1.8) with respect to \(m\) is taken, and the result set to zero, to determine the optimal frequency of violation (this implies that the denominator must be different from zero). Thus
\[
\frac{dV}{dm} = K = \left[p_a q_m(.) - c(E_m) - RFPr_m \right] (\delta + Pr(m)) - Pr_m \left[ m p_a q_m(.) - mc(E_m) - RFPr(m) \right] = 0
\]  

(2.3)

Note that for \( m \) to be optimal, it is required that the numerator of equation (1.8) to be >0. Equation (2.3) shows that \( \delta + Pr(m) > Pr_m \) using the concavity condition of the profit function.

Since \( m \) is implicit in equation (2.2), we derive the comparative static of \( m \) with respect to \( F, R, Pr, C, p_a \) and \( \delta \)

2.1 Probability of paying the fine \( R \) (enforcement)

\[
\frac{dK}{dR} = (-FPr_m)(\delta + Pr(m)) + Pr_m FPr(m) = FPr_m (-\delta - Pr + Pr)
\]

\[
= -FPr_m \delta < 0
\]

(2.4)

Equation (2.4) has to yield a negative value since the denominator is +ve and \( F, Pr_m(m) \) and \( \delta \) are all +ve values, e.g. hazard rate is increasing in frequency of violation \( m \). This result \( \frac{dK}{dR} < 0 \) together with the satisfaction of the second order conditions of value function\( \nu(.) \),

\[
\frac{dK}{dR} < 0 \text{ which implies that, } \frac{dm}{dR} = \frac{dk}{dr} / \frac{dk}{dm} < 0
\]

Result 2.4 implies that violation rate – frequency (optimal \( m \)) decreases with an increase in the probability of paying a fine \( (R) \) if detected.

2.2 Level of fine

\[
\frac{dK}{dF} = (-RPr_m)(\delta + Pr(m)) + Pr_m RPr(m) = RPr_m (-\delta - Pr + Pr)
\]

\[
= -RPr_m \delta < 0
\]

(2.5)
Following the same argument as above (denominator is +ve and $R$, $Pr_m$ and $\delta$ are all +ve values) it is clear that $\frac{dK}{dF} < 0$, which implies that $\frac{dm}{dF} = \frac{dk}{dF} / \frac{dm}{dk} < 0$ frequency of violation (optimal $m$) decreases with an increase in the amount of the fine ($F$).

2.3 Probability of detection $Pr(m)$

\[
\frac{dK}{dPr(m)} = [p_a Q_m(\cdot) - c(E_m) - RFPr_m] + RFPr_m = \pi(m)_m + RFPr_m < 0 \quad (2.6)
\]

For result (2.6) to yield the expected negative sign (negative impact of probability of detection on violation rate) expected marginal fine should be greater than the discounted marginal gain from violation. This will hold true for larger values of $Pr(m)$ implying that the higher the probability of detection, the lower is frequency of violation.

2.4 Discount rate

\[
\frac{dK}{d\delta} = p_a Q_m(\cdot) - c(E_m) - RFPr_m > 0 \quad (2.7)
\]

The non-negativity of Result 2.7 is implied by the condition of optimality derived in equation 4.15 for violating fishers (e.g. for $m > 0$). Result 2.7 accordingly suggests that violation rate increases with higher discount rates, i.e. less important is the future.

2.5 Return from violation (price of illegal catch)

\[
\frac{dK}{dp_a} = Q_m(E_m, s)(\delta + Pr - Pr_m) \geq 0 \quad (2.8)
\]

As we mentioned before, at optimal levels of $m$ the adjusted probability of detection is greater than the marginal risk of detection (equation 2.3), which implies non-negativity of Result 2.8, which suggests that frequency of violation increases with higher prices of (returns from) illegal (mixed) catch.

2.6 Fixed cost of illegal net – $c$

\[
\frac{dK}{dc(\cdot)} = -\delta - Pr + mPr_m =? \quad (2.9)
\]
Result 2.9 is indeterminate. For this to yield the expected negative effect of cost of acquiring the illegal net, the following must hold:

\[ Pr_m < \frac{\delta + Pr(m)}{m} \]  \hspace{1cm} (2.10)

Condition 2.10 simply requires that the incremental risk of being caught (marginal chance of detection) should be less than the average expected gains from not violating (opportunity cost of waiting for next period plus probability/opportunity of being caught) per violation attempt.
Annexure B

1. Calculation of the modified model

Annexure B1 shows all the steps for the integration to calculate the expected net present value of illegal gain using the modified two times dynamic deterrence model. As noted in the text

\[ u(m) = \pi(m) - z(s) - d(x), \quad u(0) = \pi(0), \]

substituting for \( u(m) \); \( u(0) \) in the value function and integrating gives the followings:

\[
J(m) = E \int_0^T e^{-\delta t} u(m) \, dt + E \int_T^\infty e^{-\delta t} u(0) \, dt - e^{-\delta T} F \quad \ldots …
2. Calculating the Probability density (the relations between the density function and proportional hazard rate)

This is straightforward calculation to get the proportional density function $g(.)$ from the hazard formula and inserts the final results in the maximisation equation.

$$\Pr(T, m, v, n) = B(m, v, n)h(T)$$

With the survival function given by:

$$h(\tau) = \frac{g(\tau, m, n, v)}{1 - G(\tau, m, n, v)}$$

Integrating both sides we get

$$\int_{0}^{T} h(\tau, m, n, v) \, d\tau = -\ln \{1 - G(\tau, m, n, v)\}$$

Hence

$$1 - G(\tau, m, n, v) = \exp \left( - \int_{0}^{t} h(\tau, m, n, v) \, d\tau \right)$$

Which can written as

$$1 - G(\tau, m, n, v) = e^{\left(- \int_{0}^{t} h(\tau, m, n, v) \, d\tau \right)}$$

If the periodic harvest in this model is assumed to be constant overtime then

$$1 - G(\tau, m, n, v) = e^{\left(- \int_{0}^{t} h(\tau, m, n, v) \, d\tau \right)}$$
1 - G(τ, m, n, ν) = e^{-B(m, ν, n)h(τ)}

G(τ, m, n, ν) = 1 - e^{-B(m, ν, n)h(τ)}

And,

g(τ, m, n, ν) = B(m, ν, n)h(τ)e^{-B(m, ν, n)h(τ)}

Substituting for \( g(τ, m, n, ν) \) in the value function we obtain:

\[
\left\{ \frac{u(m)}{δ} - \left( \frac{u(m) - u(0) + ε}{δ} \right) \int_0^∞ g(τ, m, N, ν)e^{-δτ} dτ \right\} = 2.13
\]

3. Relation between probability of detection and the discount rate

The relation between probability of detection and the discount rate calculated as follows:

\[
\frac{dD}{dδ} = -δ \int_0^∞ g(τ, m, n, ν)e^{-δτ} dτ \quad (3.1)
\]
Annexure C

1. Selected socio-economic factors that influence noncompliance with mesh size regulation

Table 1.1: Fishers’ typology in Sudan

<table>
<thead>
<tr>
<th>Violation rate</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>NV</td>
<td>30</td>
<td>12.45</td>
</tr>
<tr>
<td>OV</td>
<td>122</td>
<td>50.62</td>
</tr>
<tr>
<td>CV</td>
<td>89</td>
<td>36.93</td>
</tr>
<tr>
<td>Total</td>
<td>241</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Table 1.2: Violation rate and age categories

<table>
<thead>
<tr>
<th>Violation rate</th>
<th>17-37</th>
<th>37-58</th>
<th>58-79</th>
<th>79-100</th>
</tr>
</thead>
<tbody>
<tr>
<td>NV</td>
<td>3</td>
<td>16</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>OV</td>
<td>35</td>
<td>54</td>
<td>29</td>
<td>4</td>
</tr>
<tr>
<td>CV</td>
<td>36</td>
<td>31</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>74</td>
<td>101</td>
<td>56</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 1.3: Fishers’ preference about management regimes

<table>
<thead>
<tr>
<th>Violation rate</th>
<th>Government only</th>
<th>Fishers themselves</th>
<th>Co-management</th>
</tr>
</thead>
<tbody>
<tr>
<td>NV</td>
<td>0</td>
<td>9</td>
<td>21</td>
</tr>
<tr>
<td>OV</td>
<td>2</td>
<td>33</td>
<td>87</td>
</tr>
<tr>
<td>CV</td>
<td>3</td>
<td>13</td>
<td>73</td>
</tr>
<tr>
<td>Total</td>
<td>5</td>
<td>55</td>
<td>181</td>
</tr>
</tbody>
</table>

Table 1.4: Perception of fishers towards peer violators

<table>
<thead>
<tr>
<th>Violation rate</th>
<th>Fishers used small mesh size</th>
<th>Never use small mesh size</th>
</tr>
</thead>
<tbody>
<tr>
<td>NV</td>
<td>29</td>
<td>1</td>
</tr>
<tr>
<td>OV</td>
<td>122</td>
<td>0</td>
</tr>
<tr>
<td>CV</td>
<td>89</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>240</td>
<td>1</td>
</tr>
</tbody>
</table>
Table 1.5: Fishers’ perception about net type’s profits

<table>
<thead>
<tr>
<th>Violation rate</th>
<th>Small</th>
<th>Normal</th>
<th>No difference</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>NV</td>
<td>0</td>
<td>30</td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>OV</td>
<td>103</td>
<td>18</td>
<td>1</td>
<td>122</td>
</tr>
<tr>
<td>CV</td>
<td>84</td>
<td>5</td>
<td>0</td>
<td>89</td>
</tr>
<tr>
<td>Total</td>
<td>187</td>
<td>53</td>
<td>1</td>
<td>241</td>
</tr>
</tbody>
</table>

Table 1.6: Fishers’ typology and education level

<table>
<thead>
<tr>
<th>VR</th>
<th>Uneducated</th>
<th>Khalwa</th>
<th>Primary</th>
<th>Secondary</th>
<th>Hi-secondary</th>
<th>university</th>
</tr>
</thead>
<tbody>
<tr>
<td>NV</td>
<td>6</td>
<td>3</td>
<td>9</td>
<td>10</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>OV</td>
<td>32</td>
<td>14</td>
<td>39</td>
<td>4</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>CV</td>
<td>21</td>
<td>4</td>
<td>49</td>
<td>2</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>59</td>
<td>21</td>
<td>97</td>
<td>16</td>
<td>21</td>
<td>6</td>
</tr>
</tbody>
</table>

Note: VR is violation rate

Table 1.7: Fishers’ typology and household size

<table>
<thead>
<tr>
<th>Violation rate</th>
<th>1—6</th>
<th>7—12</th>
<th>13—18</th>
</tr>
</thead>
<tbody>
<tr>
<td>NV</td>
<td>7</td>
<td>21</td>
<td>2</td>
</tr>
<tr>
<td>OV</td>
<td>30</td>
<td>77</td>
<td>15</td>
</tr>
<tr>
<td>CV</td>
<td>20</td>
<td>65</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>57</td>
<td>163</td>
<td>21</td>
</tr>
</tbody>
</table>

NOTE: hh size measured by the numbers of individuals within the family

Table 1.8: Fishers’ typology and years of experience

<table>
<thead>
<tr>
<th>Violation rate</th>
<th>1—20</th>
<th>21—42</th>
<th>43—63</th>
<th>64—84</th>
</tr>
</thead>
<tbody>
<tr>
<td>NV</td>
<td>6</td>
<td>3</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>OV</td>
<td>32</td>
<td>14</td>
<td>39</td>
<td>4</td>
</tr>
<tr>
<td>CV</td>
<td>21</td>
<td>4</td>
<td>49</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>59</td>
<td>21</td>
<td>97</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 1.9: Fishers’ typology and no of crew per boat

<table>
<thead>
<tr>
<th>Violation rate</th>
<th>1—4</th>
<th>5—8</th>
<th>9—13</th>
</tr>
</thead>
<tbody>
<tr>
<td>NV</td>
<td>28</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>OV</td>
<td>101</td>
<td>18</td>
<td>3</td>
</tr>
<tr>
<td>CV</td>
<td>84</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>213</td>
<td>25</td>
<td>3</td>
</tr>
</tbody>
</table>
Table 1.10: Fishers’ typology and source of income

<table>
<thead>
<tr>
<th>Violation rate</th>
<th>Fishing only</th>
<th>Other sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>NV</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td>OV</td>
<td>109</td>
<td>13</td>
</tr>
<tr>
<td>CV</td>
<td>84</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>207</td>
<td>34</td>
</tr>
</tbody>
</table>

Table 1.11: Fishers’ typology and Cash versus credit preference

<table>
<thead>
<tr>
<th>Violation rate</th>
<th>Pay in cash</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>NV</td>
<td>11</td>
<td>19</td>
</tr>
<tr>
<td>OV</td>
<td>38</td>
<td>84</td>
</tr>
<tr>
<td>CV</td>
<td>14</td>
<td>75</td>
</tr>
<tr>
<td>Total</td>
<td>63</td>
<td>178</td>
</tr>
</tbody>
</table>
2. Questionnaire: Fishermen Compliance Behaviour to mesh size regulation measures in Sudan

Greeting, I am a fisheries researcher working at a research institute in Khartoum and I am here to administer a questionnaire on behalf of a PhD student at university of Pretoria South Africa. You have been randomly selected to participate in the fisheries science and research. Please note that all your answers and responses will be taken seriously with great confident. your participations to the questions are one of many answers by other fishers so no one can distinguishes what you are answered among all other answers .we will compensate you for the time that you spend with us by giving you 10,000 SP . Your interview will be taken with you alone to avoid interruption. Through this interview if you don’t understand any question please, ask for more explanation. If you agree about that then let us start.

Section 0: Identification

<table>
<thead>
<tr>
<th>Name</th>
<th>Code</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Q1. State</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Q2. Village</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Q3. Questionnaire number</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Q4. Enumerator</th>
</tr>
</thead>
</table>

**Section 1: Socio-economic Information**

<table>
<thead>
<tr>
<th>Q5. Date of the interview</th>
<th>Date</th>
<th>Month</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>2010</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q6. Time of start</th>
<th>Hour</th>
<th>Minute</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Q7. Time of end</th>
<th>Hour</th>
<th>Minute</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Q8. Fisher name (optional)</th>
</tr>
</thead>
</table>


Q9. Age (year)

Q10. Sex
- Male
- Female

Q11. Education Level:
- Only one answer is possible
- Uneducated
- Khalwa (Religious Education)
- Primary
- Secondary
- High Secondary
- University
- Post-graduate

Q12. How Many members in the household (number)

Q13. How many years have you been fishing (number)?

Section 2: Background Information.
Please provide the following information regarding your fishing activities

Q14. Which fishing activities of these do you use?
- Multiple answer is possible
- Net
- Vessel

Q15. Which fishing equipment do you own?
- Multiple answers are possible
- Net
- Vessel

Q17. Number of the crew?

Q18. Number of trips per month

Q19. Are you always fishing (tick correct answer/s)?
- Yes (→ Q21)
- No

Q20. If no what were you doing?
- Farming
- employed in Government/private sector
### Fishing gears maintenance

<table>
<thead>
<tr>
<th>Percent of Income</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 50 %</td>
<td>1</td>
</tr>
<tr>
<td>50 %</td>
<td>2</td>
</tr>
<tr>
<td>More than 50 %</td>
<td>3</td>
</tr>
</tbody>
</table>

### Section 3: Status of the fisheries

**Q22. How do you find the trend of the fish catch now compared to the last five to ten years?**

<table>
<thead>
<tr>
<th>Trend</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catch has been declining</td>
<td>1</td>
</tr>
<tr>
<td>Catch has been increasing</td>
<td>2</td>
</tr>
<tr>
<td>There is no change</td>
<td>3</td>
</tr>
<tr>
<td>Seasonal variation</td>
<td>4</td>
</tr>
</tbody>
</table>

**Q23. What is the impact of the following factor on the fish stock in this area?**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1). Excessive number of fishermen</td>
<td></td>
</tr>
<tr>
<td>(2). Excessive number of fishing gears/boats</td>
<td></td>
</tr>
<tr>
<td>(3). The use of small mesh size</td>
<td></td>
</tr>
</tbody>
</table>

### Section 4: Knowledge on Laws and Regulations

**Q24. Were you a member of the fishers’ association in the past 12 months?**

<table>
<thead>
<tr>
<th>Member</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>1</td>
</tr>
<tr>
<td>No</td>
<td>2</td>
</tr>
</tbody>
</table>

**Q25. Do you think other fishers use small mesh size for fishing?**

<table>
<thead>
<tr>
<th>Use small mesh size</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>1</td>
</tr>
<tr>
<td>No (→ Q27)</td>
<td>2</td>
</tr>
</tbody>
</table>

**Q26. IF YES indicate why?**

- Poor enforcement mechanism | 1
- Majority of fishermen are poor and not getting enough catch | 2
- Corruption | 3
- The level of penalty is low for the first and second time | 4
Q27. Which type of net/nets were you using (considering mesh size) in the last 12 months?

<table>
<thead>
<tr>
<th>Type of Net</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nets with small mesh size</td>
<td>1</td>
</tr>
<tr>
<td>Nets with prescribed mesh size</td>
<td>2</td>
</tr>
<tr>
<td>Both types of nets</td>
<td>3</td>
</tr>
</tbody>
</table>

5 second offence

Easy marketing because people prefer the small sizes fish

Q28. If the answer is (3) in previous question how frequency in the previous year do you use both of them?

Winter time | 1
Autumn | 2
Summer | 3
Other (to specify) | 4

Q29. In which season(s) fishers like to use nets with small mesh size?

Multiple answer is possible

Winter time | 1
Autumn | 2
Summer | 3
Other (to specify) | 4

Q30. Which net is more profitable?

The net with small size | 1
The net with normal size | 2
They are the same | 3

Q31. If we offer you two choices to buy a net that catch large amount of fish will you be able to pay in credit or cash?

Pay in cash | 1
Pay it in credit | 2

Section 5: Now we want to get your views about different regulations that are in place. The principal features of this regulation is mesh size regulation.

Q32. For each of the following statements please indicate your level of agreement or disagreement. Use these codes:

<table>
<thead>
<tr>
<th>Regulation</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gill nets (mesh less than 10 cm)</td>
<td></td>
</tr>
</tbody>
</table>
The principal reason for the following regulations (ban of gill nets of 10 cm or smaller) is to protect the fishery resources.

Q33. Indicate whether you think the above mentioned are just/fair regulations. Indicate your answer for each of the regulation in the table below. Use these codes:
1= Unfair
2=Fair

Please indicate whether you agree or disagree with the following statements. State your answer in the table below. Use these codes:
1= Strongly agree
2=Partly agree
3=Strongly disagree
4=Partly disagree

<table>
<thead>
<tr>
<th>Regulation</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gill nets (mesh less than 10 cm)</td>
<td></td>
</tr>
</tbody>
</table>

Questions | Code
---|---
Q34. The mesh size regulations, closed areas licenses and other measures are aimed at improving the long term well being of ALL fishermen | |
Q35. Views of fishermen are taken into account in the formulation of fisheries regulations. | |
Q36. (Mesh size Regulation) is not enforced consistently | |
Q37. Do fishers who violate these regulations getting away with it (i.e. not detected or penalized) | |

Section 6: We would like you to tell us about your experience with enforcement authorities during the past 24 months

Q38. How often do you see the fisheries officers in the Reservoir when you were fishing during the last 12 months? Only one answer is possible

| Always | 1 |
| Often  | 2 |
| Seldom | 3 |
| I have not seen them for almost a year now | 4 |
Q39. What do you usually do to avoid being caught fishing with small mesh size net?

<table>
<thead>
<tr>
<th>Code</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>cell phone</td>
</tr>
<tr>
<td>2</td>
<td>tie the net with small mesh to big stone and allow to sink</td>
</tr>
<tr>
<td>3</td>
<td>destroy the nets</td>
</tr>
<tr>
<td>4</td>
<td>Other (to specify)</td>
</tr>
</tbody>
</table>

Q40. Enforcement in the fishing areas is adequate

Use these codes:
1= Strongly agree
2=Partly agree
3=Strongly disagree
4=Partly disagree

Q41. Please estimate to the best of your ability the percentage of fishers who usually or always comply with any of the regulation listed in the table

<table>
<thead>
<tr>
<th>Regulation</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gill nets (less than 10 cm)</td>
<td></td>
</tr>
<tr>
<td>Gillnet (monofilament)</td>
<td></td>
</tr>
<tr>
<td>Closed areas</td>
<td></td>
</tr>
<tr>
<td>No license</td>
<td></td>
</tr>
</tbody>
</table>

Q42. Have you been arrested for violating mesh size regulations over the last 12 months?

<table>
<thead>
<tr>
<th>Code</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
<td>No (→ Q44)</td>
</tr>
</tbody>
</table>

Q43. If YES, how many times?

Q44. What action did you take to avoid been taken to court

<table>
<thead>
<tr>
<th>Code</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bribe</td>
</tr>
<tr>
<td>2</td>
<td>Discuss with policy friends</td>
</tr>
<tr>
<td>3</td>
<td>relative in the government Protect</td>
</tr>
<tr>
<td>4</td>
<td>Other (to specify)</td>
</tr>
</tbody>
</table>

Q45. What enforcement actions were taken against you for violation of the regulation over the last 3 years?

<table>
<thead>
<tr>
<th>Code</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Verbal warning</td>
</tr>
<tr>
<td>2</td>
<td>Written warning</td>
</tr>
<tr>
<td>3</td>
<td>Fine</td>
</tr>
<tr>
<td>4</td>
<td>Convicted</td>
</tr>
</tbody>
</table>
Confiscated/sizing the net | 5

Yes | 1
No | 2

Q46. Do you think that enforcement action was right given what you did?

Q47. What were the total losses to you over the past 12 months as results of the enforcement action (cost of illegal fishing)?

Q48. Compare to the previous years the chance that violator will be caught violating mesh size regulation is:

Increasing | 1
Decreasing | 2
Constant | 3
Fluctuated | 4

Q49. The fisher has violated regulations because he is very poor with big family and small children should the fisherman have done that?

Yes | 1
No | 2

Q50. Why?

Q51. In your judgment what is the view of the other fishers towards those who are violating the mesh regulation.

Is wrong to do | 1
Not wrong | 2

Q52. What is your judgment on the view that regulations should be complied with even if they are not fair

Agree | 1
Disagree | 2

Q53. What is your judgment on the view that fishermen should comply with the regulation set by the government even if the regulations are not effective in managing the fisheries

Agree | 1
Disagree | 2

Q54. In your opinion which one is good for managing
<table>
<thead>
<tr>
<th>the mesh size regulation?</th>
<th>Fishers among themselves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple answers are possible</td>
<td>2</td>
</tr>
</tbody>
</table>