Question #1

Each firm decides whether to send out 0, 1, 2 or 3 boats. These are the firms’ strategies. Their payoff is the profit they make for each combination of boats. The profit of firm 1 is the following:

\[ \Pi_1 = 240 \frac{B_1}{B_1 + B_2} - 20 \cdot B_1 \]

and firm 2’s profit can be calculated similarly. Substituting the different possibilities for \( B_1 \) and \( B_2 \) we get the following payoff matrix:

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>(0,0)</td>
<td>(0,210)</td>
<td>(0,180)</td>
<td>(0,150)</td>
</tr>
<tr>
<td>1</td>
<td>(220,0)</td>
<td>(100,90)</td>
<td>(60,100)</td>
<td>(40,90)</td>
</tr>
<tr>
<td>2</td>
<td>(200,0)</td>
<td>(120,50)</td>
<td>(80,60)</td>
<td>(56,54)</td>
</tr>
<tr>
<td>3</td>
<td>(180,0)</td>
<td>(120,30)</td>
<td>(84,36)</td>
<td>(60,30)</td>
</tr>
</tbody>
</table>

Question #2

The easiest way to figure out the NE is to realize that Firm 2 has a dominant strategy. No matter what Firm 1 does, Firm 2 wants to send out 2 boats. Given this, Firm 1’s best choice is to send out 3 boats. So the NE is (3,2), and firms make 84 and 36, respectively.
Question #3

Efficiency requires that social surplus (profits plus consumer surplus) be maximized. Since there are no consumers here, the efficient outcome is when the sum of profits is highest. This happens when Firm 1 sends out 1 boat and Firm 2 sends out none. Another way to see this is that since the catch is constant at 240, we want to have it at the lowest cost. This gives the same conclusion.

Question #4

If Firm 1 owns the fishing ground, it makes 220 if it denies access to Firm 2 and sends out one boat. The best Firm 2 can offer is 210, since this is the highest profit it can make. So Firm 1 will not negotiate; it will send out one boat and Firm 2 will send out none.

If Firm 2 owns the ground, its highest profit is 210. Since Firm 1 can make 220 at best, it can buy out Firm 2 by offering anything between 210 and 220 and still make positive profit. So bargaining will take place, and the outcome is again (1,0).

No matter who owns the fishing ground, the outcome will be (1,0) which is socially efficient. This is precisely what the Coase Theorem predicts. Firms’ profits, of course, differ between the two scenarios: whoever owns the fishing ground ends up with the bulk of the money.

Question #5

The most important thing to realize is that access rights are not exclusive. Even if Firm 1 buys some, it cannot prevent Firm 2 from fishing. Indeed, as we saw in Question #1, Firm 2’s dominant strategy is to send out 2 boats. Since Firm 1 is rational, it knows that. So when deciding how many licenses to buy, it only looks at its profits in the third column (see the payoff matrix). Since license fees have to be paid per boat, and the highest profit per boat is 60 (see cell (1,2)), this is the most Firm 1 is willing to pay to send out a boat.

Question #6
The argument made in the previous section suggest that the efficient outcome can never be achieved. The reason is, once again, that Firm 2 cannot commit not to fish, no matter how high a fee Firm 1 pays.

Notice that as long as rates are "fair", this is also the case when Firm 1 has property rights. Unless it charges very high rates (that would probably be deemed as "unfair"), Firm 2 will choose to buy a license.

**Question #7**

The lowest fee that is needed to reach the efficient outcome is $90 plus a tiny number. At that price the NE equilibrium is (1,0) (you can check it using the payoff matrix, just subtract 90 times the number of boats the firms send out from each payoff). If the fee is smaller, Firm 2 wants to send out 1 boat if Firm 1 sends out 1.