Advantages and Disadvantages of Introducing Strong User Rights in Fisheries

A Literature Review.

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Structure of the presentation.

Plan:

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1. Introduction.

Property rights: A right to a physical and nonphysical phenomena (see Alchian, 1965 and Demsetz, 1967).

Following Scott (1996) and (2008) four attributes of property rights are important:

a. Security. The probability that an owner can keep the property right.

b. Exclusivity. The ability to manage the property right without outside interference.

c. Durability. The time span the property right cover.

d. Transferability. The ability to transfer the property right to other people.

Departing from these four attributes Arnason (2000) and (2207) propose a quality index to measure the strength of property rights.

ITQs obtain a high quality index score while open-access obtain a low score.

1. Introduction.

User rights: A subset of property rights. A right to harvest from fish stocks (see Arnason, 2007).

The quality index for property rights can be used to measure the strength of user rights.

Strong user rights (SURFs) obtain a high quality index score, moderate strong user rights (MURFs) receive a medium score while weak user rights (WURFs) obtain a low score.

It is important to discuss advantages and disadvantages of various user right regimes for fisheries.

Arnason and Runolfson (2022) and (2023) assume a given value of the quality index to identify economic, environmental and social effects of introducing SURFs.

For a shift from WURFs to SURFs the economic and environmental effects are mainly positive while the social effects might be negative.

1. Introduction.

An alternative is to conduct a literature review to identify advantages and disadvantages of introducing SURFs.

Thus, the purpose of this presentation is:

> "Summarize advantages and disadvantages of introducing SURFs by conducting a review of the literature".

I will distinguish between:

a. Efficiency-related economic effects.

b. Nonefficiency-related economic effects.

c. Social effects.

d. Environmental or biological effects.

I will mainly focus on efficiency-related economic effects and only discuss what I believe is the most important nonefficiency-related economic effects, social effects and environmental or biological effects.

2. Methodological issues.

Plan:

A. Defining WURFs, MURFs and SURFs.

B. Short-run and long-run effects.

C. Partial effects.

D. Rent concepts.

2. A. Methodological issues: Defining WURFs, MURFs and SURFs.

We operate with three prototypes of user right regimes:

a. WURFs represented by open-access.

b. MURFs represented by IQs.

c. SURFs represented by ITQs.

Since we conduct a literature review it is assumed that:

a. The difference between WURFs and MURFs is whether fisheries is quantity regulated. Thus, we restrict attention to exclusivity when comparing WURFs and SURFs.

b. The difference between MURFs and SURFs is whether individual quotas is tradable. Thus, we restrict attention to transferability when comparing MURFs and SURFs.

2. B. Methodological issues: Short-run and long-run effects.

- For efficiency-related economic effects we distinguish between short-run and long-run impacts.
- Conventional fisheries economic literature (see Clark, 1991):
  - a. Short-run effects is related to dynamic adjustment paths of the fish stock towards a steady-state equilibrium.
  - b. Long-run effects is when the fish stock is in a steady-state equilibrium.
- General economic literature (see Varian, 1992):
  - a. Short-run effects is related to a given industry structure.
  - b. Long-run effects is when the industry structure is variable.

2. B. Methodological issues: Short-run and long-run effects.

- We depart from general economic literature and assume that long-run effects is related to a variable the industry structure. Effects on fish stocks is investigated under point 9.

  Note two facts here:

  a. If we assume that short-run effects is related to a flow variable while the long-run effects is related to a state variable the two definitions are identical.

  b. Following Hardin (1968) free entry and exit under open-access imply that the profit is zero. It is often unclear whether this effects occur in the short-run or long-run. Based on our definition it seems reasonable to argue that the impact of open-access occur in the long-run.

2. C. Methodological issues: Partial effects.

We discuss each effect separately from the other effects.

Thus, we consider the partial effect on a shift in the user right regime on one indicator separately.

Consistent with the idea behind a comparative static analysis where the effect of changing an exogenous variable on an endogenous variable is studied separately (see Varian, 1992).

However, a change in user right regimes affects various indicators in a complex way.

Analyzing this requires a general equilibrium model.

This constitute an important area for future research.

2. D. Methodological issues: Rent concepts.

For efficiency-related economic effects we depart from economic welfare.

Following Copes (1972) and Jensen et al (2019) economic welfare can be defined as the sum of the resource rent, producer surplus and consumer surplus.

More importantly it is important to distinguish between:

a. Resource rent defined by using opportunity costs of inputs.

b. Profit defined by using actual costs of inputs.

Flaaten et al (2017) show that there is a large difference between a. and b.

More importantly, Jensen et al (2019) argue that many classical papers in the fisheries economic literature does not distinguish between a. and b.

We follow this tradition and use profit instead of resource rent.

This implies that we assume that the opportunity costs and actual costs of inputs are assumed to be identical.

3. Short-run efficiency-related economic advantages.

Plan:

A. Decrease in fishing effort and increase in the profit.

B. Decrease in the harvest and increase in the price.

C. Uncertainty.

D. Second-best optimum.

E. Distribution of a total quota.

F. Decrease in congestion of fishing grounds.

G. Reduce principal-agent problems between regulator and owner.

H. Reduce principal-agent problems between owner and employee.

3. A. Short-run efficiency-related economic advantages: Decrease in fishing effort and increase in the profit.

A well-known result: A transition from WURFs to SURFs lead to a decrease in fishing effort and an increase in the profit (see Christy, 1973, Moloney and Pearse, 1979 and Scott and Neher, 1981).

Have been confirmed in many classical, empirical papers (see Arnason, 1986, Dewees, 1989, Grafton, 1992 and 1995, Gren and Nayar, 1988).

Recent empirical papers for Danish fisheries also confirm these results (see Andersen et al, 2010 and Merayo et al, 2018).

3. B. Short-run efficiency-related economic advantages: Decrease in the harvest and increase in the price.

Assume that overexploitation of fish stocks occur in WURFs and that the stock size increase when introducing SURFs.

When introducing SURFs the harvest may increase in the short-run implying that overexploitation of the fish stock is reduced (see e.g. Anderson, 2008).

Provided that the market demand function for fish products is negatively sloped the decrese in the harvest may lead to an increase in the price in the short-run (see Copes, 1972).

For a transition from WURFs to SURFs these effects have been confirmed in many empirical papers (see Grafton, 1995, Sharp and Roberts, 1991, Merayoe, 2018 and Nielsen et al, 2023).

3. C. Short-run efficiency-related economic advantages: Uncertainty.

Following Weitzman (1972) the outcome under WURFs, MURFs and SURFs may differ under uncertainty.

For fisheries a number of papers have compared the performance of various regulatory instruments under uncertainty with mixed results (see Weitzman, 2002, Hannesson and Kennedy, 2005, Hansen et al, 2005, Hansen and Jensen, 2017).

Thus, it is unclear whether WURFs, MURFs and SURFs are preferred under uncertainty.

More importantly, Jensen et al (2023) show that the empirical difference between WURFs, MURFs and SURFs under uncertainty is very small for the Danish cod fishery in Kattegat.

Thus, uncertainty is not an argument for choosing between WURFs, MURFs and SURFs.

3. D. Short-run efficiency-related economic advantages: Second-best optimum.

Following Lipsey and Lancaster (1956) we distinguish between:

a. A first-best optimum: All efficiency problems in an economy are corrected.

b. A second-best optimum: We accept an efficiency loss but given this loss we do the best we can to achieve the highest possible efficiency.

For fisheries we distinguish between:

a. Setting a total quota at an economically optimal harvest and introducing SURFs secure a first-best optimum.

b. Setting a total quota according to another scientific objective and introducing SURFs secure a second-best optimum.

As economists we must accept other scientific objectives with regulation.

This implies that we shall target a second-best optimum in the sense that we recommend SURFs even when a total quota is set according to a noneconomic objective.

3. D. Short-run efficiency-related economic advantages: Second-best optimum.

A slightly different way to capture this point is to include all relevant objectives with fisheries management in an objective function for a decision maker (see Mardle and Pascoe, 2003).

Now weights can be attached to these objectives using multicriteria decision analysis or multi-attribute utility theory.

The objective function can be used to find an optimal total quota.

This total quota is second-best optimal.

Now we can introduce SURFs implying that we target a second-best optimum.

3. E. Short-run efficiency-related economic advantages: Distribution of a total quota.

Under SURFs: A total quota is fixed and this quota is distributed to vessel owners as tradable quotas.

Trade with quotas on a market without market failures will ensure an optimal distribution of a total quota between vessels owners where the marginal profit is identical (see Frost and Jensen, 2003).

Under MURFs, where trade with quotas is impossible, an optimal distribution of a total quota requires that a huge amount of information is collected (see Frost and Jensen, 2003).

Assume also that the optimal distribution of a total quota change due to changes in the marginal profit between firms.

Under SURFs trade with quotas will secure the new optimal distribution of the total quota (see Frost and Jensen, 2003).

Under MURFs information about the change in the marginal profit must be collected (see Frost and Jensen, 2003).

3. E. Short-run efficiency-related economic advantages: Distribution of a total quota.

Thus, an advantage of using SURFs is that the problem of an optimal distribution of a total quota is solved by decentralizing decision-making to vessels owners.

Concerning trade with quotas a number of issues may arise including equity considerations, balancing use levels with resource conditions, facilitating transactions, accounting for externalities and ensuring adequate monitoring.

This implies that SURFs secure a second-best optimum.

For all fisheries around the world, where SURFs has been introduced, a number of restrictions on trade with quotas has been imposed.

One argument for these restrictions is that other scientific objectives should be taken into account (see Arnasom, 2002).

Thus, under SURFs the actual design of quota markets indicate that we target a second-best optimum.

3. F. Short-run efficiency-related economic advantages: Decrease in congestion of fishing grounds.

- Congestion of fishing grounds may cause problems (see Smith, 1968).
- Congestion may arise under WURFs (see Danielson, 2000).
- Under SURFs fishing effort will decrease.
- Fishing effort can be interpreted as an index for the amount of all inputs used when harvesting fish (see Squires, 1987).
- Empirical studies indicate that the number of fishing days can be used as an approximation for fishing effort (see Dupont, 1990).
- When introducing SURFs it can be argued that the number of fishing days decrease and this leads to a decrease in congestion (see Boyce, 1992).
- Later we will argue that the number of vessels will decrease when introducing SURFs and this also leads to a lower efficiency loss due to congestion (see Boyce, 2000).

3. G. Short-run efficiency-related economic advantages: Reduce principal-agent problems between regulator and owner.

A principal-agent relation may arise between regulator and vessels owners.

If the owners is better informed about a variable or parameter than the regulator this may cause problems (see Copes, 1986).

Under WURFs each individual vessels owner impose a stock externality on other vessels owners.

If a vessels owner have private information this externality cannot be corrected in a first-best optimal way implying that efficiency losses arise under WURFs (see Jensen and Vestergaard, 2002).

Under SURFs the vessels owner is provided with an incentive to take the stock externality into account implying that the efficiency loss due to private information is minimized (see Arnason, 1990).

The regulator can also minimize the efficiency loss due to private information by introducing video monitoring on board of fishing vessels (see McElderry, 2006).

3. H. Short-run efficiency-related economic advantages: Reduce principal-agent problems between owner and employee.

On large production vessels a principal-agent problem may arise between the owner and employees (see Jensen and Nøstbakken, 2015).

Employees on large production vessels is normally motivated by other objectives than profit.

It can also be argued that employees have private information about fishing effort.

The choice of remuneration rule can solve this problem.

A share of profit rule has been suggested as a solution (see Mathiasson, 1999).

Under WURFs the owner may be motivated by other objectives than profit so a share of profit rule is unlikely to be adopted (see Anderson, 1980).

Under SURFs the owner obtain an incentive to target the highest possible profit and it is likely that the share of profit rule will be implemented (see Arnason, 2002).

Furthermore, video monitoring may minimize the efficiency loss due to a principal-agent relation between the owner and employee (see McElderry, 2006).

4. Long-run efficiency-related economic advantages.

Plan:

A. Decrease in overcapacity.

B. Economics and diseconomics of scale.

C. Economics and diseconomics of scope

D. Incentive to invest in new technology.

E. Optimal industry structure, grandfathering and auctions.

4. A. Long-run efficiency-related economic advantages: Decrease in overcapacity.

Under WURFs overcapacity problems may arise.

Introducing SURFs implies a desirable adjustment of the fleet structure towards less overcapacity (see Grafton et al, 2000, Newel et al, 2005 and Squires et al, 2010).

Classical empirical papers have confirmed this result (Crowley and Palsson, 1992, Grafton, 1995, Cowan, 1990 and Muse and Schelle, 1989).

Recent studies of Danish fisheries have also confirmed this result (see Andersen et al, 2010 and Merayo et al, 2018).

4. B. Long-run efficiency-related economic advantages: Economics and diseconomics of scale.

Economics of scale exist when it is less costly to produce a given output in one firm instead of in several firms (see Baumol et al, 1982).

SURFs may imply a desirable adjustment in the level of horizontal integration reflecting economics and diseconomics of scale.

In a literature review Kronbak et al (2013) find that both economics and diseconomics of scale may arise at a global level so it is unclear whether horizontal integration occur.

More importantly we can investigate the level of horizontal integration.

Brandt and Hannemann (2004) find no empirical evidence for horizontal integration.

McCay (1996) report large quota concentrations under SURFs at a global level.

Thus, imperfect competition on quota markets may arise.

To address this issue we can impose limits on how large a share of a total quota vessels owners can hold (see Doring et al, 2015).

4. C. Long-run efficiency-related economic advantages: Economics and diseconomics of scope.

Economics of scope occur when it is less costly to produce several outputs in one firm than in several firms (see Baumol et al, 1982).

In fisheries two kinds of economics of scope may arise:

a. It is less costly to harvest several species by one vessel than by several vessels. This leads to horizontal integration. Huang and Lee (1976) and Committini and Huang (1976) find economics of scope in the sense that multispecies fisheries is optimal. Graftión (1998) find that SURFs for different species are concentrated on few vessels.

b. It is less costly to produce the outputs by the whole fishing industry in one firm than in several firms. This leads to vertical concentration. Kroetz et al (2019) and Varmedam et al (2019) find empirical evidence for vertical integration.

4. D. Long-run efficiency-related economic advantages: Incentive to invest in new technology.

- SURFs may generate optimal investments in new fishing technology.
- This requires that capital stocks is perfectly malleable and that there is no sunk costs (see Beddington et al, 1972).
- With non-malleable capital and sunk costs SURFs generate nonoptimal investments in new technology (see Clark et al, 1979 and Vestergaard et al, 2005).
- When comparing WURFs, MURFs and SURFs non-malleable capital and sunk costs arise under all three user right regimes.
- Since SURFs imply that vessels owners obtain an incentive to target the highest possible profit, the level of investments represent a second-best optimum with non-malleable capital and sunk costs.

4. E. Long-run efficiency-related economic advantages: Optimal industry structure, grandfathering and auction.

The optimal industry structure in the long-run is determined by the minimum of the average cost function (see Varian, 1992).

If externalities occur the damage cost of these must be taken into account in the average cost function (see Hanley et al, 1997).

Thus, for fisheries we must find a social average cost function which include the damage cost of the stock externality (see Corato and Mace, 2023).

To secure an optimal industry structure vessels owners must cover the damage cost of the stock externality.

This is secured under both grandfathering and auctions of the total quota in a system with SURFs (see Corato and Mace, 2023).

Thus, SURFs secure an optimal industry structure in the long-run irrespectively of how the total quota is allocated to vessel owners.

It can be argued that this discussion is less relevant for fisheries.

In many countries a license is required for participating in a fishery (see FAO, 2022).

This implies that the industry structure is fixed by regulation.

5. Short-run efficiency-related economic disadvantages.

Plan:

A. Costly monitoring and enforcement.

B. Random fluctuation in annual quota.

C. Substitution between regulated and unregulated species.

D. Discard of nontarget species.

E. High grading.

5. A. Short-run efficiency-related economic disadvantages: Costly monitoring and enforcement.

Under MURFs and SURFs it is necessary to introduce a compliance end enforcement policy (see Copes, 1986).

Paslow (2010) argue that the outcome under WURFs, MURFs and SURFs become identical without such a policy.

The explanation for this result is that a harvest restriction is imposed on each vessels owner under MURFs and SURFs.

Without a compliance and enforcement policy each vessels owner will exceed the harvest restriction such that we reach the same outcome under WURFs, MURFs and SURFs.

For this reason a monitoring and enforcement policy has been implemented for all fisheries regulated with MURFs and SURFs at a global level (see Interpol, 2018).

5. A. Short-run efficiency-related economic disadvantages: Costly monitoring and enforcement.

Equally important introducing a compliance and enforcement policy is costly.

Thus, monitoring and enforcement costs should be taken into account when setting a total quota in systems with MURFs and SURFs (see Sutinen and Andersen, 1985).

A number of empirical papers have shown that the marginal monitoring and enforcement costs is significant (see Mace, 1985, Hannesson, 2000 and Wallis and Flaaten, 2000).

This implies that compliance and enforcement costs will have a significant effect on the total quota under MURFs and SURFs.

However, monitoring and enforcement costs can be minimized by introducing video monitoring on activities on board vessels (see McElderry, 2006).

5. B. Short-run efficiency-related economic disadvantages: Random fluctuation in annual quota.

MURFs and SURFs are normally distributed to vessels owners as a fixed share of a total quota.

Relative stability, where quotas is allocated based on historical harvest, is an example of this.

If the total quota varies randomly in response to random variations in the stock size the annual quota allocation to vessels owners will also vary in a stochastic way (see Walters and Pearse, 1996).

If we compare situations with uncertainty and certainty about the annual quota allocation risk-averse vessels owners will experience a loss in the expected profit under uncertainty (see Nguyen and Leung, 2009).

5. B. Short-run efficiency-related economic disadvantages: Random fluctuation in annual quota.

- However, the risk-attitude will probably vary between vessels owners (see Eggert and Martinsson, 2004).
- If vessels owners are risk-lovers they will experience a gain in the expected profit under uncertainty.
- The choice of user right regime also have consequences for who cover the risk due to uncertainty about the annual quota allocation.
- Under SURFs vessels owners covers the risk and this may be a less desirable effect (see Francis and Shutton, 2011).
- A solution to this problem is to offer a complete and fair insurance to vessels owners to protect against random variations in the annual quota allocation (see Rothshild and Stiglitz, 1976).

5. C. Short-run efficiency-related economic disadvantages: Substitution between regulated and unregulated species.

Normally, SURFs are introduced for some species while WURFs are used for other species.

Several empirical papers have shown that undesirable substitution between regulated and unregulated species may arise (see Asche et al, 2007, Ekerhovd, 2007 and Pascoe et al, 2007).

If WURFs is used for all species an optimal substitution between species may occur (see Branch and Hilborn, 2008).

It is difficult to compare the incentive to substitution between species under MURFs and SURFs.

However, species regulated with WURFs are normally less important from a commercial point of view implying that the efficiency loss due to substitution between species may be low (see Hutniczak, 2014).

5. D. Short-run efficiency-related economic disadvantages: Discard of nontarget species.

In a multispecies fishery discard of nontarget species may cause problems (see Pascoe, 1997).

Here the production technology is important and it is reasonable to assume that various fish species is harvested in variable proportions.

Boyce (1996) compare the incentive to discard under WURFs and SURFs.

It is argued that WURFs on target species lead to extensive discard.

Furthermore, SURFs can only secure an optimal distribution of harvest between target and nontarget species if the total quota is fixed in a way that takes variable proportions in the production technology into account.

Note that a discard ban has been introduced in the European Union (see Sarda et al, 2015).

It must be expected that the marginal costs of discard become very high for low levels of discard.

Thus, a discard ban is nonoptimal (see Pascoe, 1997).

In the environmental economic it is normally argued zero pollution is non-optimal and this is the same basic point (see Hanley et al, 1997).

5. E. Short-run efficiency-related economic disadvantages: High grading.

- Under MURFs and SURFs high-grading may cause problems (see Copes, 1986).

  High-grading implies that fish species of year-classes with a low value are discarded to land fish of year-classes with a high value (see Arnason, 1994).

  High-grading occur because a common quota on the biomass of fish is imposed on all year-classes.

  Thus, the incentive to high-grading does not exist under WURFs since vessels owners can land fish without any restriction (see Arnason, 1994).

  There is an incentive to high-grading under MURFs and SURFs but value-based quotas may solve this problem (see Turner, 1997).

5. E. Short-run efficiency-related economic disadvantages: High grading.

- However, value-based quotas raises huge information requirements since the price and marginal costs of harvesting all year-classes of a fish species must be known.

  Within an age-structured model two problems with a common quota on the biomass of fish may raise (see Tahvonen, 2009):

  a. Recruitment overfishing where fish is harvested at a non-optimal young age. This leads to a low future spawning stock biomass.

  b. Spawning stock overfishing where the harvest of the spawning stock biomass is too high. This leads to a low future recruitment.

  Following Quass et al (2013) SURFs that are differentiated between year-classes may solve a. and b.

6. Long-run efficiency-related economic disadvantages.

Only one long-run disadvantage: Under SURFs the transition period before optimal industry structure is reached may be long (see Weninger and Just, 1997).

Explanations for this is sunk costs, nonmalleable capital and adjustment paths for fish stocks over time (see Weninger and Just, 1997).

However, a long transition period also occur under WURFs and MURFs (see Vestergaard et al, 2005).

Under WURFs and MURFs the optimal industry structure is not reached in the long-run while the optimal industry structure is obtained under SURFs.

Thus, a long transition period before the optimal industry structure is reached is not an argument against SURFs.

7. Major nonefficiency-related economic effects.

Plan:

A. Multipliers.

B. Tax revenue.

C. Stability.

D. Value of fishing rights.

E. Employment.

F. Distribution.

7. A. Major nonefficiency-related economic effects: Multiplier.

Since the profit increase when introducing SURFs, the overall economic activity may increase due to macroeconomic multiplier effects (see Jacobsen et al, 2014).

A multiplier effect captures all derived effects for other sectors in the economy due to an increase in the profit (see Greenlaw and Shapiro, 2011).

Two multiplier effects:

a. Short-run multiplier effect where it is assumed that an increase in the economic activity does not affect the price level. At a global level Jacobsen et al (2014) find short-run multipliers on 1.82 indicating that an increase in the profit on 10 Euro will generate an additional increase in the economic activity of 8.2 Euro.

b. Long-run multiplier effects where it is assumed that an increase in the economic activity increase the price level. Jacobsen et al (2014) find long-run multipliers on 1.65.

Jacobsen et al (2014) also show that the multipliers is significantly higher for developed than for less developed regions.

Thus, when introducing SURFs developed regions in a country will gain more than less developed regions.

7. B. Major nonefficiency-related economic effects: Tax revenue.

It is important to finance public expenditures by collecting tax revenue.

Since the introduction of SURFs imply an increase in the overall economic activity the total tax revenue may also increase.

When introducing SURFs it is unclear what happens to the tax revenue generated by the fishing industry (see Salgado et al, 2018). Two possible effects:

a. The profit from harvesting fish increase which tend to increase the tax revenue.

b. Below we will argue that employment in both the primary fishing industry and secondary industries decrease which tend to decrease the tax revenue.

When introducing SURFs the relative contribution of various sectors to the tax revenue will also change (see Stage et al, 2016). Two possible effects:

a. The fishing industry will generate a lower share of the tax revenue.

b. Other sectors will generate a higher share of the tax revenue.

Since the multipliers are larger in developed than in less developed regions within a country, the relative contribution to the tax revenue will increase for the former but decrease for the later.

7. C. Major nonefficiency-related economic effects: Stability.

Below we will argue that introduction of SURFs may increase the fish stock.

Thus, the stability of fishing effort, harvest and profit will tend increase (see Anderson et al, 2015).

If vessel owners are risk-averse this is an advantage of introducing SURFs.

However, random fluctuations in the annual quota allocation may lead to less stability.

Furthermore, SURFs may increase investments in new and more efficient technology which may decrease fish stocks.

Therefore, the stability of fishing effort, harvest and profit will tend to decrease.

7. D. Major nonefficiency-related economic effects: Value of fishing rights.

The value of fishing rights reflects the present value of the current and future profit from harvesting fish (see Costello and Deacon, 2007).

Introduction of SURFs may increase the value of fishing rights since the profit increase (see Gallic, 2003).

Since trade with quotas is possible under SURFs, the value of fishing rights can be realized on a market.

Thus, the owners of SURFs can realize the capital gain from an increase in the value of fishing rights (see Reimer et al, 2014).

7. E. Major nonefficiency-related economic effects: Employment.

When introducing SURFs the effect on the employment is difficult to predict. Three possible effects:

a. The overall employment tend to increase since the economic activity increase.

b. Fishing effort and the number of vessels will decrease implying that the employment in primary fishery tend to decrease.

c. The harvest will decrease which tend to decrease in the employment in the processing industry.

Due to a., b. and c. it is important that labor is mobile between industries.

Furthermore, it is important that labor is mobile between regions in a country since the effect of introduction of SURFs differ between regions.

7. F. Major nonefficiency-related economic effects: Distribution.

When introducing SURFs there is an unequal distribution of advantages and disadvantages.

Possible effects:

a. The quota concentration may increase implying an unequal distribution of the profit among vessels owners.

b. There is an unequal distribution in the overall economic activity between regions.

However, since the overall economic activity increase the following effects may arise (see Doring et al, 2015):

a. The losers may obtain alternative opportunities.

b. The winners may compensate losers.

8. Major social effects.

Plan:

A. Power and social status.

B. New production methods.

C. Change in property right structure.

D. Ideological arguments.

8. A. Major social effects: Power and social status.

When introducing SURFs the power and social status structure will change.

Power is transferred from regulator to the fishing industry (see Acheson et al, 2015).

Under SURFs private vessel owners may potentially affect fisheries management (see Coelho, 2018).

When shifting away from SURFs it can be difficult for regulator to regain power over fisheries management (see Browmley, 2009).

The power and social status structure also change between geographical regions within a country (see Bromley, 2009).

The distribution of income will also change. Two possible effects:

a. Efficient vessels obtain a higher income while inefficient vessels obtain a lower income (see Stage et al, 2016).

b. Developed regions in a country which is highly dependent on fisheries obtain a high income while poor regions obtain a lower income.

8. B. Major social effects: New production methods.

As mentioned above investments in new and more efficient production technologies can be stimulated when introducing SURFs.

Thus, the culture associated with previous production methods will be replaced by a culture in accordance with new production methods.

Furthermore, efficient vessels will tend to stay in the industry while vessels with inefficient vessels may have to exit (see Schnier and Felthoven, 2013).

Thus, there is a shift in the culture in the sense that fishing becomes more commercial with a higher focus on profit.

8. C. Major social effects: Change in property right structure.

When introducing SURFs social conflicts may arise (see Hallman and Herborth, 2008).

An example is the Cod Wars between United Kingdom and Iceland (see Steinsson, 2016).

These wars occurred because the Icelandic government decided to expand their national limits to territorial waters.

However, vessels from United Kingdom harvested cod close to the Icelandic coast.

During the Cod Wars vessels from United Kingdom reacted strongly to the expansions of the national limits by Iceland (see Gudmundsson, 2006).

8. D. Major social effects: Ideological arguments.

Introducing SURFs represent privatization of natural resources.

From a political science perspective liberals argue that SURFs shall be introduced while socialists prefer a regime where the state has the user right (see Burges et al, 2021).

Despite this result from political science many value-based and political arguments for an against SURFs can be mentioned (see Coelho, 2018).

These arguments is irrelevant for this paper since the purpose is to conduct an objective scientific investigation of the advantages and disadvantages of introducing SURFs.

9. Major environmental and biological effects.

Plan:

A. Increase in stock size.

B. Lower probability of catastrophic events.

C. Ecosystem-based approach.

D. Pollution.

E. Health of ecosystems.

F. Multispecies fisheries.

9. A. Major environmental and biological effects: Increase in stock size.

Fish stocks is normally on an adjustment path towards a steady-state equilibrium and these paths can be complicated even within a single-species model (see Conrad and Clark, 1987).

From above we have that introducing SURFs will decrease fishing effort and the harvest in the short-run.

Thus, within a single-species model the stock size of fish may increase in the short-run on an adjustment path towards a steady-state equilibrium (see Clark and Munro, 1975).

This is an important advantage of introducing SURFs.

In the long-run an increase in the stock size may generate an increase in the harvest (see Arnason, 2002).

9. B. Major environmental and biological effects: Lower probability of catastrophic events.

It is often argue that unexpected, stochastic and catastrophic events may lead to extinction of fish stocks (see Belhabib et al, 2018).

Within a single-species model introducing SURFs may imply a lower probability for such events since the fish stock increase (see Hoshina et al, 2020).

Under SURFs it is also easier for vessels owners to react to catastrophic events since these have the right to harvest fish (see Hoff, 2013).

This discussion is related to unknown thresholds for fish stocks.

Crossing the thresholds lead to extinction of fish stocks.

When introducing SURFs the stock size will increase so the probability of crossing unknown thresholds decrease within a single-species model.

9. C. Major environmental and biological effects: Ecosystem-based approach.

It is often argued that fisheries policies shall be determined by departing from an eco-system based approach in the sense that the benefits and costs of all stakeholders shall be taken into account (see Curlin and Prellezo, 2010).

To discuss this issue it is useful to introduce the Coase theorem according to which bargaining among people involved in an externality problem can generate optimality.

This requires that the property right structure is well defined and that there is no transaction costs (see Coase, 1960).

Under SURFs the property rights structure is well defined implying that bargaining between users of marine areas can secure optimality as defined by an eco-system based approach (see Arnason, 2009).

9. C. Major environmental and biological effects: Ecosystem-based approach.

However, the Coase theorem is based on a number of restrictive assumptions (see Farrell, 1987). Three examples are:

a. Zero transaction costs.

b. Prefect information about the payoff functions of other users.

c. Limited number of participants in bargaining.

A number of laboratory experiments have shown that an optimal solution to externality problems is not obtained with bargaining if these assumptions are violated (see Mabsout and Radmond, 2019).

Despite this fact introducing SURFs imply that the property right structure is well defined.

Thus, the outcome of bargaining between users of marine areas can be interpreted as a second-best optimal solution.

9. D. Major environmental and biological effects: Pollution.

Fisheries generate a number of pollution problems with CO2, NOx, HC and SOx as examples (see Zigler and Hansson, 2003).

Due to a decrease in fishing effort and harvest in the short-run introduction of SURFs will decrease these emissions (see Merayou et at, 2018).

Waldo et al (2016) have shown that a transition from WURFs to SURFs will reduce CO2 emissions by approximately 50 % in selected Nordic countries.

However, when taking pollution into account we have two externalities given by a stock externality and pollution.

To generate a first-best optimum the number of regulatory instruments and externalities shall be identical (see Weitzman, 1978).

Using one instrument to correct two market failures only generate a second-best optimum (see Weitzman, 1978).

9. D. Major environmental and biological effects: Pollution.

Thus, if we only introduce SURFs when pollution is an additional externality we reach a second-best optimum.

To reach a first-best optimum we can combine SURFs with a tax on pollution.

It is often difficult to use several regulatory instruments since they may interact in an unpredictable way.

Furthermore, it can be difficult for vessel owners to understand the incentives generated by several regulatory instruments (see Gai et al, 2019).

Thus, it seems reasonable to target a second-best optimum and only introduce SURFs even when pollution is an externality problem.

9. E. Major environmental and biological effects: Health of ecosystems.

Introduction of SURFs may imply an increased incentive to protect marine environments since the property rights are allocated to vessel owners.

Specifically, vessel owners may be motivated to show increased concern for the health of marine ecosystems since doing so may increase the profit in the long-run (see Branch, 2009).

Thus, owners of SURFs will try to avoid external impacts from other users of marine areas.

However, this requires that vessel owners obtain a positive profit from keeping marine ecosystems healthy.

This is not obvious since the costs of doing so can be very high (see Chen et al, 2022).

Introduction of SURFs will also increase investments in new technology implying that the health of marine ecosystems may decrease.

9. F. Major environmental and biological effects: Multispecies fisheries.

Within a multi-species model the implications of introducing SURFs can be difficult to predict.

Specifically, within a multi-species model dynamic adjustment paths towards a steady-state equilibrium can be very complicated and unstable.

However, when introducing SURFs the stock size of predators may increase (see Qguz, 2007).

An increase in the stock size of predators may decrease the biodiversity in marine ecosystems since the number of prey species will decrease (see Ellingsen et al, 2015).

SURFs may also increase investments in new and more efficient technologies which may decrease the biodiversity in marine areas (see Pusceddu et al, 2014).

10. Summary.

We have conducted a literature review to identify advantages and disadvantages of introducing SURFs.

We have focused on efficiency-related economic effects but have also summarized major nonefficiency-related economic effects, social effects and biological effects.

We have investigated each effect separately but in reality all effects interacts in a complex way to determine the final outcome.

To take interaction between effects into account in an economic analysis require a general equilibrium model.

Using such a model to analyze the implication of introducing SURFs constitute an important area for future research.