Question 1

- Demand : $P = 15 - 0.5Q$
- $Q_1 + Q_2 = 20$
- $MC = 4$
- $r = 0,05$

a) The equilibrium for the two periods is where the marginal net benefit (MNB) is equal in both periods. This is because this is where the total net present value is maximized. To find the equilibrium we first need to calculate the MNB in both periods. MNP equals the price minus the benefits, and for the second period we need to discount it, to find it in the present value.

$$MNB_1 = P - MC$$
$$= 15 - 0.5Q_1 - 4$$
$$= 11 - 0.5Q_1$$

$$MNB_2 = \frac{P - MC}{1+r}$$
$$= \frac{15 - 0.5Q - 4}{1 + 0,05}$$
$$= 10.48 - 0,48Q_2$$

Can now find the equilibrium ~~price~~ ~~or~~ quantity for each period by solving the following set of equations:

$$(1)\ Q_1 + Q_2 = 20 \Rightarrow Q_1 = 20 - Q_2$$
$$(2)\ MNB_1 = MNB_2$$

Put in our calculated values for the MNB's:

$$(2) \Rightarrow 11 - 0{,}5Q_1 = 10{,}48 - 0{,}48Q_2$$

Set in for Q_1 from (1):

$$11 - 0{,}5(20 - Q_2) = 10{,}48 - 0{,}48Q_2$$
$$11 - 10 + 0{,}5Q_2 = 10{,}48 - 0{,}48Q_2$$
$$0{,}98Q_2 = 9{,}48$$
$$Q_2 = \underline{9{,}67}$$

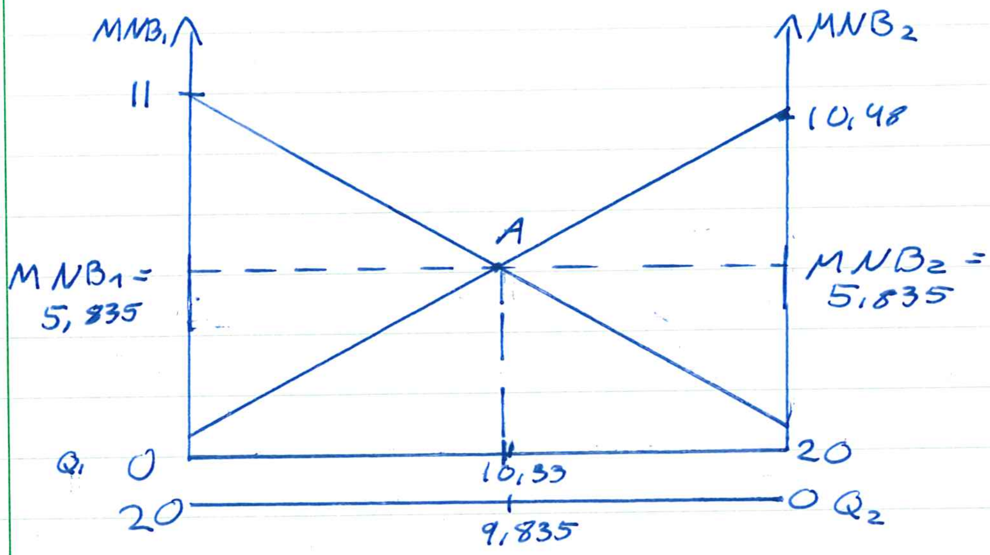
$$Q_1 = 20 - 9{,}67 = \underline{10{,}33}$$

So that the equilibrium ~~p~~ quantity in period 1 is ~~X~~ 10,33 and ~~the e~~ TO 9,67 in period 2. Can put these values into our demand function to find the $ price in each period.

$$P_1 = 15 - 0{,}5 \cdot 10{,}33 = \underline{9{,}835}$$

$$P_2 = 15 - 0{,}5 \cdot 9{,}67 = \underline{10{,}165}$$

Can see this equilibrium in a diagram:



The equilibrium is in A, where $Q_1 = 10,33$, $Q_2 = 9,67$ and the MNB is 5,835 in both periods.

b) The marginal user cost (MUC) is the alternative cost of using the good now, which causes more scarity for the future.

It is different from the marginal cost of extraction, because the more we extract, the less of the depletable resource is left for the future. ~~This increases the ~~m~~ MUC~~ The MUC equals the difference between the price and the marginal cost of extraction (MCC). When we use more of the resource, it becomes more scare, and the price increase. This is why the MUC is equal to the MCC for renewable resources, as renewable resource dont have any scarity, as it is renewable.

MUC for period 1:

$MUC_1 = P - MC = 9{,}835 - 4 = 5{,}835$

MUC for period 2:

$MUC_2 = 10{,}165 - 4 = 6{,}165$

As explained above, we see that the MUC increase over time.

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c) The allocation of resources across two periods is not fair, as we favour the ~~future~~ present by using more of the depletable good now than in the future.

This will be the case as long as we have a positive discount rate. For the future to be favoured the discount rate need to be negative, which is unrealistic.

When making this estimation we also assume the demand is the same in both ~~perio~~ periods. This might not be the case, as ~~de~~ preferences might change over time. ~~We might be ass~~

Leaving the future ~~with~~ off with less of the resource than the present is not fair. However, if the demand is equal for both periods this is the optimal allocation, and optimality isn't necessarily fair.

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Question 2

a) A public good is a good that is non-rivalry and no-excludable.

Non-rivalry means that one's use of the good does not decrease others use of a good. An example here is a radio-signal. If you are listening to a radio channel, it doesn't stop others from doing it as well. A rivalry good could for example be a park which fills up, decreasing the welfare for the users the more full it gets, eventually fulling up, hindering others from using it.

A non-excludable good is a good that you can't exclude anyone or any group from using. A non-excludable good could for example bea the ocean - you can't stop anyone from taking a bath. ~~But~~ A similar good that is excludable is a pool, which for example could be excluding groups by only letting hotel guest or paying visitors use it.

A public good is both ~~no~~ non-rivalry and non-excludable. An example is national defence. It is non-rivalry as the defence protects the whole community at once, as well as you cant exlude any part of the population, e.g. non-tax payers, from benefitting from it.

The market does often not provide efficient levels of a puplic good because of the free-rider principle. Since the good is non-excludable people can get of with not paying for a good and still enjoying the benefits of it. ~~If the pub~~ This will be seen by a decrease in demand in a perfect free market. This is why the government often take responcibilty for producing public goods, as they can deal with payment through taxes, decreasing the problem of free riders.

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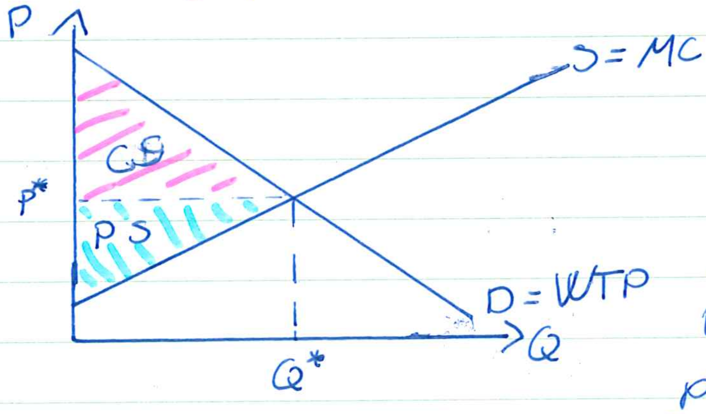
b) The economic surplus is maximized where demand equals supply, and intuitively where ~~mar~~ willingness to pay equals the producers marginal cost. Can see this in a graph:



Here P = price, Q = quanity, S = supply, MC = Marginal cost, D = demand, WTP = willingness to pay, CS = consumer surplus PS = producer surplus.

The economic surplus equals the sum of consumer and producer surpluses. This is matimized here as for a lower price, the producer still ~~to~~ will earn more ~~toy~~ as their costs are below what the consumers are willing to pay. ~~For a~~ For a price over ~~the~~ P* the ~~producer will be~~ consumers wont request the given amount. ~~and ther~~

When we have an externality we have that the production of the good affects a third party, giving it either benefits or cost, ~~to~~ which the producers dont take to account. When we have a negative externality, we get a cost upon the society, causing a higher social marginal cost (MCs) than the

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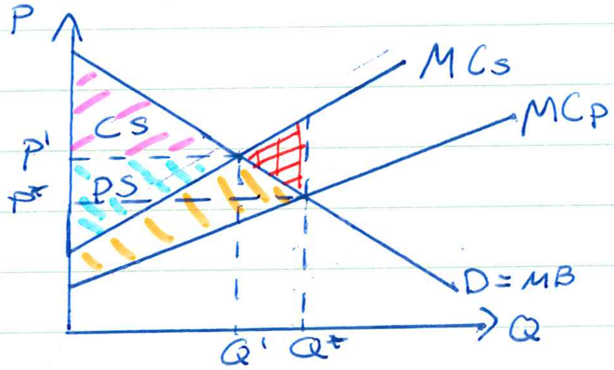
~~private~~ producers marginal cost (MC_p). ~~Ca~~ Can see this graphically:



Demand is also equal to marginal benefits, MB.

The optimal solution for the producer is at Q*, P*, where the profits are maximized. However, the optimal solution for the society is at Q', P', at a higher price and a higher quantity.
Without intervention the producer will produce at Q*, P*, as it will lose copmetetiveness if it doesn't. This leads to an efficiency loss, which equals the red ~~area~~ area where the ~~social~~ MCs is higher than the MB.

The total surplus is now equal to the pink and blue area as before, but now we have to subtract our efficiency loss, the red area. This causes a reduced economic surplus.

The orange area is a neutral area, as it is an equal cost to society as it is a benefit to the producers.

c) The property rights will either be assigned to the polluter or the non-polluter that is affected.

We assume that if the polluter pollute, the non-polluter get a low income level, and that if the polluter will pollute if it gots property rights.

If the non-polluter gets property rights, it will decide that the polluter can not pollute, reducing the polluters earnings and maximizing its own.

If the polluter has the property rights, the non polluter will pay the polluter to reduce its production, say buy using a filter. The non-polluter will be willing to pay up to its increased profit buy using the filter compared to the non-filter profit. The polluter will accept as long as the payment is above what it would earn by not using the filter. This way ~~it~~ both would be better off.

If the non-pollater has property rights, it is the other way around. The polluter will pay to ~~to~~ produce with a filter, paying up to a level that would still increase its

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benefits. The non-polluter would accept as long as it also could increase its benefits.

See that we end up with the same solution independent on whom have the property rights - so it doesn't matter who has the property rights - the level of production will and pollution be the same. This is called the Coase theorem. Even though production will be the same, who has the property rights will have an effect on the distribution of wealth.

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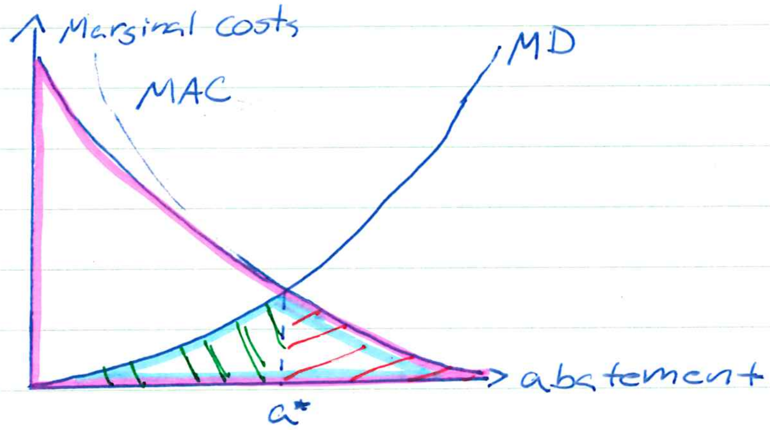
~~Op~~ Question 3

a) The optimal level of pollution is where the marginal damage equals the marginal cost of abatement.
The marginal damage (MD) is the damage to the environment by ~~producing~~ polluting one extra unit.
The marginal abatement cost (MAC) equals the producers cost by reducing pollution by one extra unit. This could be ~~buy~~ by es. using a filter, reducing production etc.

We can see why ~~this~~ the optimal amount often is not equal to zero by using a graph:



The optimal level of ~~the~~ pollution is at a* level of abatement, where MAC = MD. The social cost is here equal to the total damage cost, the green shredded area, and the ~~AA~~ total ~~co abatement~~ cost, equal to the red shredded area. Giving a total social cost of the blue triangle.

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When we have 0 pollution, we have no damage cost, but we have an increased abatement cost, equal to the pink triangle. Can easily see that the total social cost (with no pollution the pink triangle) is bigger than the total social cost at the optimal level of pollution. Therefore see that the optimal amount of pollution typically isn't zero - it doesn't minimize the costs to society.

b) $MC_1 = \$100q_1$ and $MC_2 = 50q_2$

Without government intervention: $q_1 = q_2 = 10$

~~↳ Q = ... units of emitted pollution~~

Now the total abatement of 10: $q_1 + q_2 = 10$
The cost effective allocation is where the firms marginal abatement costs are equal. Can find the quantity of this by solving the following set of equations:

(1) $MC_1 = MC_2$

(2) $Q_1 + Q_2 = 10 \Rightarrow Q_1 = 10 - Q_2$

Put in values for (1):

$100Q_1 = 50Q_2$

Solve for Q_2:

$100(10 - Q_2) = 50Q_2$

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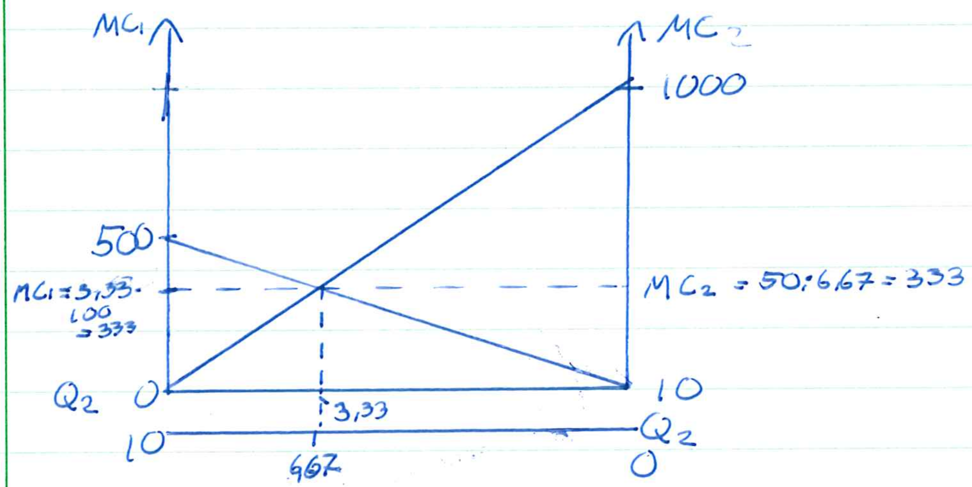
$$1000 - 100Q_2 = 50Q_2$$
$$150Q_2 = 1000$$
$$Q_2 = 6,67$$

$$Q_1 = 10 - 6,67 = 3,33$$

Can see this by a diagram:

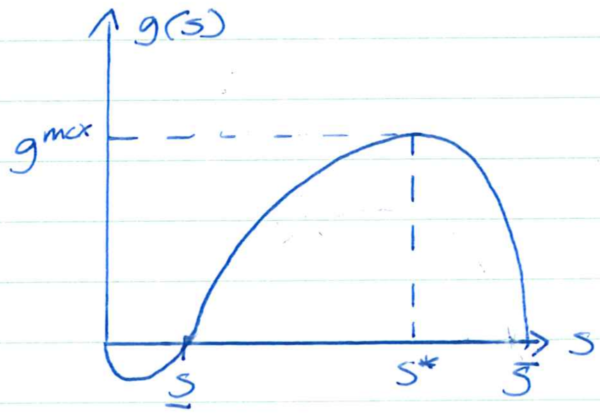


See that Firm 1 will have to abate more, as they have the lowest cost of abatement.

c) The charge must be equal to where $MC_1 = MC_2$. See that this gives us a charge of 333 ($3,33 \cdot 100 = 50 \cdot 6,67 = 333$). This is because here the firms will internalize the cost of abatement, "forcing" them to produce at this level, because this would be optimal for them as well. With no tax, both firms would not abate, as the cost of reducing pollution then wasn't internalized, it was an externality.

Question 4

a) To look at the sustainable yield of fisheries, we first look at the biological model:



S - Fish stock size

g - growth

This model shows the relationship between the size of a fish stock, S, and the growthrate of the fish stock, g(S).
See that from $\underline{S}$ to S^* the population growth increase with the size of the stock. From S^* to $\bar{S}$ the growth decrease with the size of the stock. $\bar{S}$ is the stocks natural equilibrium.

We can introduce harvest as a function of effor to our graph, to look at the sustainable yield.

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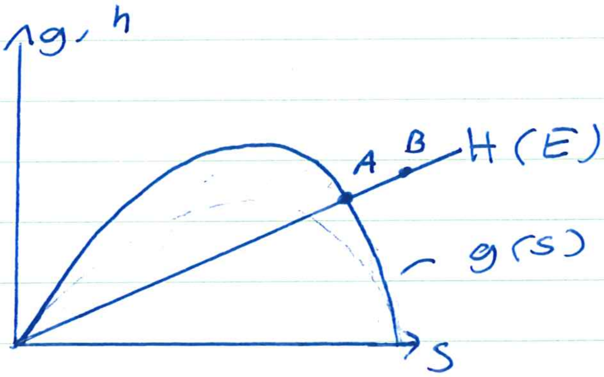
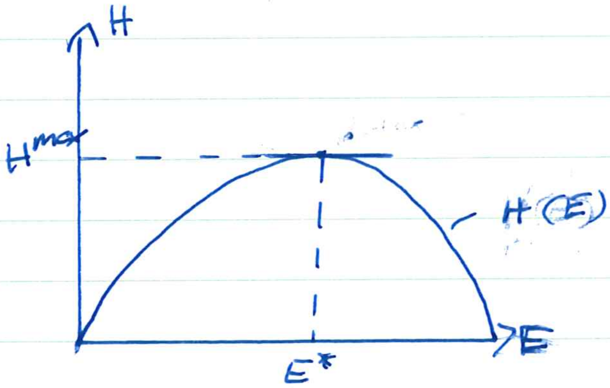


E - effort
H - harvest

Effort could here be number of boats, fishermen etc. The sustainable yield is where the harvest function equals the growth function in A. This is because if we harvest the growth, the fish stock will remain the same size. If we harvest more than the growth, for example at B, the fish population will be reduced in the next period. Can draw all these sustainable yields in a diagram:



As long as we harvest along the H(E) curve the ~~sust~~ ~~maximum~~ sustainable yield will be maintained.
The maximum sustainable yield is found where the harvest is at its highest along the curve

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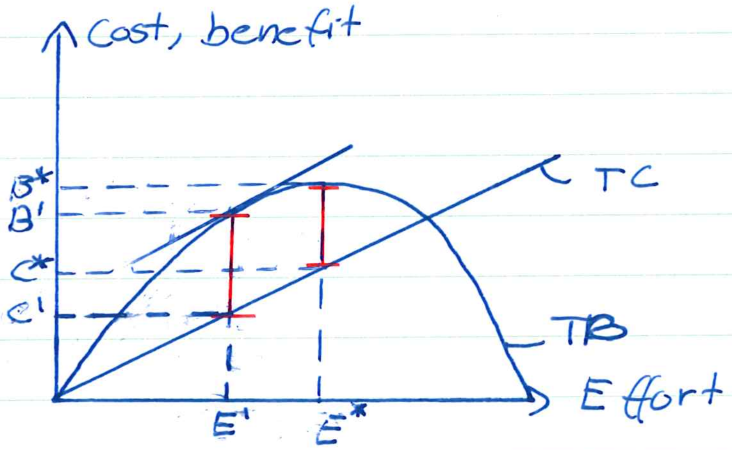
b) To find the economic sustainable yield we need to introduce cost and benefits. We assume a constant price, meaning our total benefits (TB) equals the price times the harvested level, and therefore follows the same pattern as the harvest curve. Also assume a flat MC-curve, giving a Total cost (TC) curve that increases constantly with the effort. Can see this in a diagram:



The most efficient economic yield is where the difference between the TB- and TC-curve is the greatest - where they have the same incline. This is at E', where benefits equal B' and cost equal C'. The profit then equals B' - C'. At the maximum sustainable harvest yield, E*, we see that the difference between the benefits, B*, and the costs, C*, is smaller, causing a smaller profit. The two different profits is marked by the red lines.

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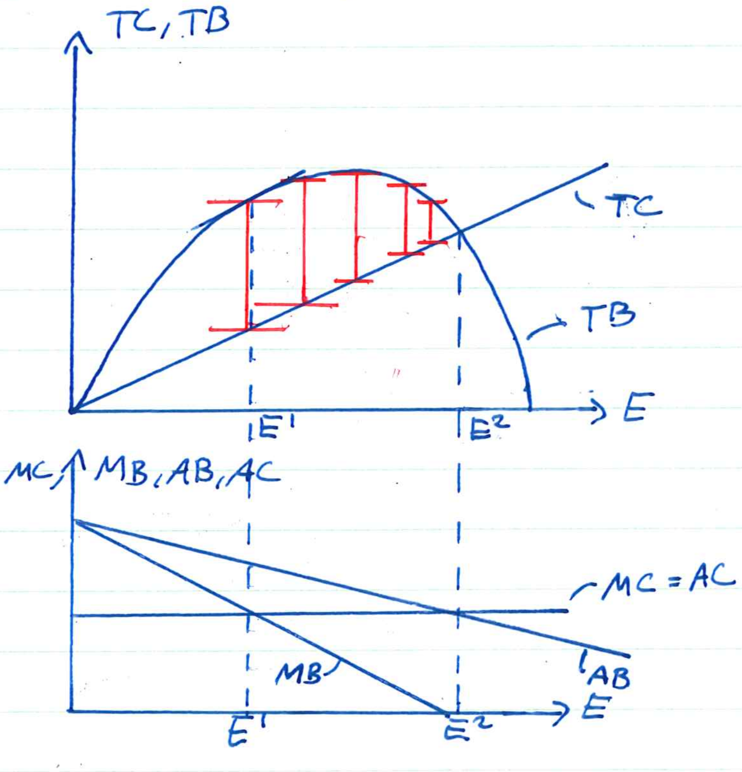
See that the economic efficient yield differs from the maximum sustainable yield, showing that harvesting the maximum amount does not equal the biggest profits.

c) Open acsess resources are resources that are rivalry and non-excludable. We can use a lake as an example. It is non-rivalry as we cant stop anyone from fishing in it, ~~but~~ meaning it is non-excludable but it is rivalry in the sense that there is only a ~~the~~ fixed amount of fish that can be caught. Can see how this results in inefficient rates of harvesting by looking at ~~•~~ the model used in b):



AC = average cost
MC = marginal cost
MB = marginal benefit
AB = Avrage benefit

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When we only have one fisherman, he will end up in the economic efficient solution, as this will maximize the profits.

~~However when more fishermen join the~~ fish at the lake, they ~~will fish until the point where TC = TB~~. This is because until this point, benefits are still greater than costs, giving incentives to ~~start~~ start fishing at the lake. Can see this development by the red lines. As long as there are profit, more fishermen will start fishing at the lake.

This continues until $E = E^2$, where $TB = TC$ and $AB = AC$. ~~This~~ This is ~~not~~ an inefficient level of harvest, as profits are not maximized and this is called the tradgedy of the commons.

When other fishermen ~~start~~ see the possibility for profits, they will start fishing at the lake, causing an increase in effort. More fishermen will join until the point where $TC = TB$. After this, it isn't more profit to collect from fishing at the lake

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