COEXIST - Interaction in European coastal waters: A roadmap to sustainable integration of aquaculture and fisheries, Baltic Case Study

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Pariseapate, Riga, November 1st 2013
1. COEXIST at a glance

- **Title:** COEXIST - Interaction in European coastal waters: A roadmap to sustainable integration of aquaculture and fisheries
- **Programme:** FP7, Cooperation, Food, Agriculture and Fisheries, and Biotechnology (KBBE)
- **Instruments:** Coordination and Support Action (Coordination action)
- **Total budget:** €3,777,931
- **EC contribution:** €2,995,500
- **Duration:** April 2010 – March 2013 (extended until June 2013)
- **Consortium:** 13 partners from 10 countries
- **Coordination:** Institute of Marine Research, Norway
- **Web:** [www.coexistproject.eu](http://www.coexistproject.eu)
3. Consortium and Case Studies

1. HARDANGERFJORD – LP: IMR
2. ATLANTIC SEA COAST - LP: UCC
3. ALGARVE COAST - LP: IPIMAR
4. ADRIATIC SEA COAST – LP: CNR-ISMAR
5. COASTAL NORTH SEA – LP: TI-SF
6. BALTIC SEA – LP: FGFRI
Three aspects of sustainability

- Environmental
- Institutional
- Economic
- Social
Rainbow trout farmed in Finland

Source: kalankasvatuksen ympäristönsuojeluohje

Real value
Inland waters
Sea

Value, million €
Production, million kg

Source: kalankasvatuksen ympäristönsuojeluohje
Market growth by imported salmon
Present structure of the fish farming

Dispersed in small units
A fish farming company has usually many sites
Loading has decreased

Total nitrogen and phosphorus loading

Spesific nitrogen and phosphorus loading

Source: kalankasvatuksen ympäristönsuojeluohje
Life cycle environmental impacts of different fish farming alternatives in the Baltic Sea

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Chemicals production

Electricity production

Heat production

Fuels production

Fishing

Fish meal and oil production

Soy, wheat, rape seed production

Processing
- Soy meal & concentrate
- Wheat flour
- Rape seed oil

Feed manufacturing

Smolt production

Fertilisers

Pesticides

Antifouling

Fish farming

Materials production

Interaction in coastal waters
Fish farming options

0. Present situation

1. **Net loading option** (fisheries of low-valued stocks for nutrient removal to justify aquaculture licenses)

2. **Baltic Sea feed** (nutrient recycling within the Archipelago fisheries and aquaculture)

3. **Rationalized farming site location strategy** (fewer, bigger and better located farms)

Environmental indicators

- Climate change (carbon footprint, CO$_2$-equiv.)
- Eutrophication of the waters (PO$_4$-equiv.)
- Primary energy consumption (GJ)
<table>
<thead>
<tr>
<th>Management options – what differs?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Net loading</strong></td>
</tr>
<tr>
<td>Fish feed (FF) raw materials production</td>
</tr>
<tr>
<td>Feed manufacturing</td>
</tr>
<tr>
<td>Transport</td>
</tr>
<tr>
<td>Smolt production</td>
</tr>
<tr>
<td>Infra (at farm)</td>
</tr>
<tr>
<td>Adjoining system (fuels, electr, heat, chemicals)</td>
</tr>
<tr>
<td>Other</td>
</tr>
</tbody>
</table>
Current case: results

Energy consumption (GJ per 1000 kg of fish)

- Soy products
- Wheat
- Fish meal and oil
- Other feed raw materials
- Fish feed manuf.
- Hatchery
- Fish farming
- Transports
- Packages

Energy consumption ranges from 0 to 12 GJ per 1000 kg of fish, with fish meal and oil showing the highest consumption.
Comparison: energy consumption

- LVF catching
- Packages
- Transports
- Fish farming
- Hatchery
- Fish feed manuf.
- Other feed raw materials
- Fish meal and oil from BS
- Fish meal and oil
- Wheat
- Soy products
Comparison: climate and eutrophication

![Bar chart comparing current, net loading, offshore, and BS-feed with a relative scale ranging from -0.4 to 1.4. The bars indicate the comparison between these factors.]
Conclusions

• Present system:
  • Decrease nutrient load from fish farming (practically & technically)
  • Use renewable energy and utilize organic wastes maximally
  • Be awake to the environmental impacts of feed raw materials production

• Net loading: present system and…
  • Result is very sensible for the end use of LVF: if not used in BD production but replaces fish used in fur animal feeding ⇒ net effect ≤ 0
  • Minimise fuel consumption of LVF fishing

• Offshore: see present system

• BS feed: see present system, and…
  • Minimise fuel consumption of fishing
  • A new alternative ⇒ composition of the fish feed is not known yet ⇒ may (significantly) affect to the final results
Site selection plan, objectives

- Recognize the areas especially suitable for aquaculture
- Diminish conflicts and nutrient loading in the inner archipelago
- Harmonize economic and environmental policies to make the aquaculture sustainable
- Make the farming more profitable

Sources:

http://info.ices.dk/products/CMdocs/CM-2012/Q/Q0212.pdf

http://www.mmm.fi/attachments/kalariistajaporot/lausuntopyynnot/6E3Tm6zDH/Vesiviljelyn_kansallinen_sijainninohjaussuunnitelma_110113.pdf
Satakunta county as a pilot

• Criteria from a national committee
• A regional planning committee with broad participation
• Expert hearings
• Recognizing the suitable areas with background data using GIS-tools
• Modelling the future production figures
• Environmental impact assessment
Criteria: ecological status and usefulness classification of water areas
Criteria: Water depth, Summer houses and the recreational use in the regional plan
Criteria: Nature protection and Natura areas
Criteria: other uses, like shipping routes, military use
### The areas recognized

<table>
<thead>
<tr>
<th>Area</th>
<th>Area</th>
<th>Excluded</th>
</tr>
</thead>
<tbody>
<tr>
<td>SW inner archipelago</td>
<td>681 km²</td>
<td>94 %</td>
</tr>
<tr>
<td>SW middle archipelago</td>
<td>1285 km²</td>
<td>76 %</td>
</tr>
<tr>
<td>SW outer archipelago</td>
<td>4217 km²</td>
<td>53 %</td>
</tr>
<tr>
<td>Gulf of Bothnia inner coast</td>
<td>828 km²</td>
<td>95 %</td>
</tr>
<tr>
<td>Gulf of Bothnia outer coast</td>
<td>1543 km²</td>
<td>72 %</td>
</tr>
<tr>
<td>Archipelago and coastal area</td>
<td>554 km²</td>
<td>67 %</td>
</tr>
</tbody>
</table>
Modelling the nutrient flow

Currents

Nutrient load dispersion
Change in the algae amounts

Changes in the chlorophyll contents (%)

[Map showing changes in algae amounts]
In the archipelago Sea, zones gathering small units together
Consequences in the Archipelago Sea according to the plan

- Algae content increase less than 4%
- The number of farming units by the participating companies will be 60% less
- More than 80% less summer houses under 0.5 km distance from the farms
Most promising areas for the future growth

• less sheltered
• offshore farming techniques
• Wind power parks?
Profitability threshold
A good plan for the farmers?

1. Profitability
2. Concurrence from Norway and Sweden (Estonia)
3. Heavy burden of permit bureaucracy
Towards interactive fish farming governance? a comparison of Finland and Sweden

Mäkinen Timo, Salmi Pekka & Forsman Leena


Finnish Game and Fisheries Research Institute
Fish farming governance goals in the Baltic Sea area

Decreasing adverse ecological effects;
Optimization of the use of coastal areas at regional, nation-wide and the Baltic Sea level;
Creating and maintaining firm jobs opportunities to private fish farmers in the rural archipelago areas;
Supporting regional fisheries and economic development
<table>
<thead>
<tr>
<th></th>
<th>Sweden</th>
<th>Finland</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Production</strong>&lt;br&gt;(million kg)</td>
<td>12.0</td>
<td>11.3</td>
</tr>
<tr>
<td><strong>Value of production,</strong>&lt;br&gt;(million €)</td>
<td>36.8</td>
<td>47.1</td>
</tr>
<tr>
<td><strong>Share of rainbow trout</strong>&lt;br&gt;of the production</td>
<td>89.8 %</td>
<td>87.6 %</td>
</tr>
<tr>
<td></td>
<td>The rest mainly arctic char</td>
<td>The rest mainly whitefish</td>
</tr>
<tr>
<td><strong>Number of farms (food fish)</strong></td>
<td>79</td>
<td>178</td>
</tr>
<tr>
<td></td>
<td>of which in the Baltic Sea coast</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>(only rainbow trout)</td>
<td>111</td>
</tr>
<tr>
<td><strong>Farms producing more than 100 tons/a</strong></td>
<td>15</td>
<td>only few</td>
</tr>
<tr>
<td></td>
<td>Producing 95 % of the Swedish production</td>
<td></td>
</tr>
</tbody>
</table>

(Statistics Sweden (SCB), Statistics Finland (SVT))
Swedish Production 1983-2011
Swedish production and number of farms in 2011

Annual production (tons) / number of farms

174/9
2744/6
2824/5
433/5
1528/5
2786/11
1052/4

Counties with production >100 tons:
- Norrbotten
- Västerbotten
- Västernorrland
- Jämtland
- Dalarna
- Värmland
- Västra Götaland
- Skåne

Statistics Sweden (SCB)
Finnish production 1980-2010 (tons/a) and number of farms in 2010

Source: Kalankasvatuksen ympäristönsuojeluohje

Real value
Inland waters
Sea

Production, million kg
Value, million €

Source: Kalankasvatuksen ympäristönsuojeluohje
A permit needed when, 

**Sweden**

- When use of dry feed exceeds 40 tons/a, a permit from regional county is needed. If it is between 1,5-40 tons/a, a notification to the local municipality serves (the environmental legislation)
- According to the Fishery Act all aquaculture needs a permit from the regional county

**Finland**

- When production (=plusgrowth) exceeds 2 tons/a or use of dry feed 2 tons/a
- Or if the size of a pond culture is at least 20 ha
Legislation

Very similar in both countries
Permit is required according to water and environment legislation in Finland and fisheries and environmental legislation in Sweden
One application is adequate in both countries
Rearing conditions has to be accepted according to animal protection act in Sweden
### Swedish application system

**Consultations**
- County Administrative Board
- Regulatory authority (municipality)
- Individuals specially affected by the project

**Environmental impact?**
- County Administrative Board makes a decision whether an application can be prepared and sent forward

**Broader Consultations**
- County Administrative Board
- Supervisory/regulatory authorities
- Individuals specially affected by the project
- Other state authorities, municipalities, organizations, groups affected by the project

**Application with MKB**
- Application
- MKB (Environmental Impact Description) including report of consultations
- Information to the general public

**Decision**
- County Administrative Board decides if MKB is valid
- County Administrative Board accepts the application

### Finnish application system

**Application**
- Regional State Administrative Agencies

**Possible supplements and consultations**
- Regional State Administrative Agencies
- Centre for Economic Development, Transport and the Environment management (ELY-center)
- Information to general public

**Comments**
- Regulatory authority (ELY-center, 2 departments)
- Municipality
- Individuals specially affected by the project

**Possible consultations**
- Regulatory authority (ELY-center)
- Regional State Administrative Agencies

**Decision**
- Regional State Administrative Agencies

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Sweden according to Jens Andersson
Swedish system / Finnish system

Actors:
no differences, more or less the same actors

Institutions:
the role of the local level (municipality) is much stronger in Sweden

Governance:
Sweden: more interaction, collaboration and public-private partnership
Finland: more hierarchical governance, less communication

Principles/main focus:
Sweden: local society and environment
Finland: effluent loads of nitrogen and phosphorus
Monitoring

**Sweden**

Counties often delegate monitoring to the municipalities.

Mainly similar as in Finland:
- Annual and loading reports prepared by farmers
- Inspector’s visits depending on the case (may in some cases be several times a year)

**Finland**

The Centre for Economic Development, Transport and the Environment is monitoring.

- Annual and loading reports prepared by farmers
- Inspector visits every second year
The Swedish governance practice*:

- Large farms in Sweden (over 1000 tons) in the lake area,
- In the sea area the capacity of the farms owned by Finns are 400-600 tons
- Farm sites are excellent, oligotrophic areas, depth 40-60m, no registered complaints although the farms are located near shores
- More difficult to get permits for sea than for lake areas, - for sea areas permits are usually for 10-15 years,
- -for lake areas permits are for an indefinite time
- Spatial plan is generally not yet in use in Sweden as it is going to be in Finland in 2013

*interview of a Chief executive of a Fish farming enterprise in Åland islands
The differences between the two countries*:

“Swedish permit application system is heavy and lasts long (at least half a year) Environmental Impact Description (MKB) laborious.” The process is easier in Åland county in Finland.

“The real power in Sweden is with the MPD (Environment Advisory Board of County Administrative Board)

Structural policy in Sweden is less supportive (less national funding) and meticulous bureaucracy after the support has been granted

The biggest difference between the two countries is in markets and marketing: there is no big rainbow trout market in Sweden”

*interview of a chief executive of a Fish farming enterprise in Åland islands
Finnish farmers going “to exile” into Sweden*

Over 5 million kg annually “Finnish” production in Sweden

Big farms, big plans:

“We have now a million kg farm but it is planned to produce 4 million kgs on that farm in the near future. This plan is prepared in understanding with the local environmental authorities and with their consultative help.”

The Production exported to Finland

“There is no market for big rainbow trout in Sweden”

Sometimes the fish goes first to Estonia to be processed before exportation to Finland

*The chief executive of a Finnish fish farming company
Are the governance goals in the Baltic Sea area in balance between the regions?

Decreasing adverse ecological effects;
Optimization of the use of coastal areas regionally, nation wide and at the Baltic Sea level;
Creating and maintaining firm jobs opportunities to private fish farmers in the rural archipelago areas;
Supporting regional fisheries and economic development
Economy of alternative production methods

1. **Micro economy**
   - Standpoint: profitability of fish farm enterprises
   - Production costs < market price
   - Amortizing the investments = economic sustainability

2. **Macro economy, national economy**
   - Profitability makes production figures to increase
   - Competitiveness starts the investments
   - Investments, jobs, profits = value added = gnp = taxes = Well fare services
   - Production amount * price of the product = Value of the production
   - Availability of a reasonable priced healthy food stuff

3. **Regional economy - Coexist case Study the Archipelago Sea**
   - Creating jobs for the rural area
   - Indirect impacts: maintaining the services
   - Indirect impacts: 2 * Value of the production
Baltic Sea Feed

Benefit – increased production amount

- Incentive (National Aquaculture Programme) => 1.5 * permit => 300 tons farm => production costs decrease 0.26 €/kg => benefit 0.22 €/kg
Nutrient compensation by low value fish removal

1. Increased costs
   - Payment to fisherman about $0.58/kg
   - Reduce the value of the fish as fur animal feed raw material $0.20/kg
   - Remainder $0.38/kg * 1.1 = cost of one kg increased production (National Aquaculture Programme) = $0.42/kg

2. Benefit
   - Increased production decreases share of fixed cost, see the graph before
   - If the farm produces 300 tons and fixed costs are about $0.79/kg, a 150 tons increase in production decrease the production cost to $0.52/kg, thus, the benefit is $0.10/kg
   - Profitable if the fixed costs are at least $0.41/kg
   - Or if the market price of the fish is high
Spatial planning: site selection

Background: more open areas with better water exchange allow bigger units
Economic impacts: site selection

Osxt and benefit

Theoretically profitability will increase about 0.10 - 0.15 €/kg
- In practice 0.14 - 0.47 €/kg (Many units merged + labor effectiveness * 2)

<table>
<thead>
<tr>
<th>Production option</th>
<th>BAU</th>
<th>Near</th>
<th>Far</th>
<th>2 units</th>
<th>2 * production</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B1</td>
<td>B2</td>
<td>C1</td>
<td>C2</td>
</tr>
<tr>
<td>Personel costs</td>
<td>€/kg</td>
<td>€/kg</td>
<td>€/kg</td>
<td>€/kg</td>
<td>€/kg</td>
</tr>
<tr>
<td>Cage and fish transfer</td>
<td>0.058</td>
<td>0.027</td>
<td>0.007</td>
<td>0.034</td>
<td>0.011</td>
</tr>
<tr>
<td>Feeding/ observation</td>
<td>0.045</td>
<td>0.024</td>
<td>0.003</td>
<td>0.028</td>
<td>0.004</td>
</tr>
<tr>
<td>Fuel costs</td>
<td>0.042</td>
<td>0.011</td>
<td>0.005</td>
<td>0.021</td>
<td>0.009</td>
</tr>
<tr>
<td>Cage and fish transfer</td>
<td>0.012</td>
<td>0.003</td>
<td>0.003</td>
<td>0.006</td>
<td>0.006</td>
</tr>
<tr>
<td>Feeding/ observation</td>
<td>0.030</td>
<td>0.008</td>
<td>0.002</td>
<td>0.015</td>
<td>0.003</td>
</tr>
<tr>
<td>Investments</td>
<td>0.598</td>
<td>0.527</td>
<td>0.590</td>
<td>0.527</td>
<td>0.590</td>
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<tr>
<td>Boats</td>
<td>0.086</td>
<td>0.086</td>
<td>0.086</td>
<td>0.086</td>
<td>0.086</td>
</tr>
<tr>
<td>Feeding equipment</td>
<td>0.026</td>
<td>0.003</td>
<td>0.067</td>
<td>0.003</td>
<td>0.067</td>
</tr>
<tr>
<td>Cages and equipment</td>
<td>0.486</td>
<td>0.437</td>
<td>0.437</td>
<td>0.437</td>
<td>0.437</td>
</tr>
<tr>
<td>Logistic cost total</td>
<td>0.698</td>
<td>0.564</td>
<td>0.601</td>
<td>0.582</td>
<td>0.610</td>
</tr>
<tr>
<td>Change in production cost</td>
<td>0.000</td>
<td>-0.133</td>
<td>-0.096</td>
<td>-0.116</td>
<td>-0.088</td>
</tr>
</tbody>
</table>
Micro economy: summary

• With all alternative methods profitability will increase if production is allowed to increase or many small units merged to a big unit
• Low value fish removal as a compensation do not decrease the production costs if the company is a big one with a small share of the fixed costs

<table>
<thead>
<tr>
<th>Production cost by volume</th>
<th>Business as usual</th>
<th>Baltic feed</th>
<th>Low value fish</th>
<th>Centralizing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume in cost breakdown</td>
<td>300 ton</td>
<td>450 ton</td>
<td>450 ton</td>
<td>300 ton</td>
</tr>
<tr>
<td>Variable cost</td>
<td>2,67</td>
<td>2,71</td>
<td>2,81</td>
<td>2,61</td>
</tr>
<tr>
<td>Semi variable cost</td>
<td>0,34</td>
<td>0,34</td>
<td>0,34</td>
<td>0,27</td>
</tr>
<tr>
<td>Fixed cost</td>
<td>0,79</td>
<td>0,53</td>
<td>0,53</td>
<td>0,79</td>
</tr>
<tr>
<td>Production cost</td>
<td><strong>3,80</strong></td>
<td><strong>3,58</strong></td>
<td><strong>3,68</strong></td>
<td><strong>3,67</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Production volume (ton)</th>
<th>Production cost</th>
<th>Production cost</th>
<th>Production cost</th>
<th>Production cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td><strong>3,80</strong></td>
<td><strong>3,84</strong></td>
<td><strong>3,94</strong></td>
<td><strong>3,67</strong></td>
</tr>
<tr>
<td>450</td>
<td><strong>3,54</strong></td>
<td><strong>3,58</strong></td>
<td><strong>3,68</strong></td>
<td><strong>3,40</strong></td>
</tr>
<tr>
<td>600</td>
<td><strong>3,41</strong></td>
<td><strong>3,40</strong></td>
<td><strong>3,48</strong></td>
<td><strong>3,27</strong></td>
</tr>
<tr>
<td>1200</td>
<td><strong>3,21</strong></td>
<td><strong>3,31</strong></td>
<td><strong>3,31</strong></td>
<td><strong>3,07</strong></td>
</tr>
</tbody>
</table>
Macro economy: summary

- On the level of the national economy the practical constraints are taken into account:

1. Baltic Sea Feed: 2 000 tons assumed production increase is based on present production figures, compensation factor value and on interviews of the farmers

2. Low value fish removal: 500 tons assumed production increase is based on evaluation of regions where the lv fish, fishermen and fish farmers are encountering each others

3. Spatial planning: 3000 tons assumed production increase is based on recognised potential farming regions and on the willingness of the companies to invest on those areas

- Total effect: ? Finnish production * 2

<table>
<thead>
<tr>
<th></th>
<th>Potential increase ton of fish production</th>
<th>Realistic increase ton of fish production</th>
<th>Direct production value Million of euros</th>
<th>Indirect added production value Millions of euros</th>
<th>Employment direct person years</th>
<th>Indirect added employment person years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baltic feed</td>
<td>4 000</td>
<td>2 000</td>
<td>11</td>
<td>22</td>
<td>106</td>
<td>220</td>
</tr>
<tr>
<td>Compensation fishing</td>
<td>4 000</td>
<td>500</td>
<td>3</td>
<td>6</td>
<td>27</td>
<td>55</td>
</tr>
<tr>
<td>Spatial planning</td>
<td>10 000</td>
<td>3 000</td>
<td>16</td>
<td>32</td>
<td>119</td>
<td>285</td>
</tr>
</tbody>
</table>
Regional economy: summary

• Sout-Western Finland, the rural archipelago area

• Value added with indirect effects total 55 million euros

• Employment increases with indirect effects about 450 person year to the region

• Domestic fish production increase about 3 250 000 kg

• Other market effects? Availability of local fish, better fish selection on the market, prices down?

<table>
<thead>
<tr>
<th></th>
<th>Potential increase ton of fish production</th>
<th>Realistic increase ton of fish production</th>
<th>Direct production value Million of euros</th>
<th>Indirect, added production value Millions of euros</th>
<th>Employment direct person years</th>
<th>Indirect, added employment person years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baltic feed</td>
<td>1 500</td>
<td>1 000</td>
<td>6</td>
<td>11</td>
<td>53</td>
<td>110</td>
</tr>
<tr>
<td>Compensation fishing</td>
<td>2 000</td>
<td>250</td>
<td>2</td>
<td>3</td>
<td>13</td>
<td>27</td>
</tr>
<tr>
<td>Spatial planning</td>
<td>5 000</td>
<td>2 000</td>
<td>11</td>
<td>22</td>
<td>80</td>
<td>166</td>
</tr>
</tbody>
</table>
1. Significant economic impacts if production figures are allowed to increase
   - Management should take the incentives to form an essential part of the system
   - Depends on the incentives how extensive the application of the methods will be

2. Voluntary – no enforcement
   - Availability of raw materials may change
   - Practical contraints for some companies
   - Profitability low -> incentives only

3. If no incentives, which the consequences will be?
   - Disappering of the domestic fish from the market?

4. Low value fish, feed fish, should be used as human nutrition
Eutrophication vs. climate change

0.8%

0.03%
Conclusions

Fish produced with Baltic Sea feed in (more) open sea areas is the most sustainable way to produce animal protein

1. Its environmental impacts may be less than that of chicken, beef, or pig production
2. Healthy food stuff
3. Market based prices: no direct production support
Recommendations

• The Baltic Sea feed should be taken into use
• The national site selection plan for aquaculture should be put into practice through a concrete system with clear terms. The system should be an essential part of the aquaculture permit process
• Marine spatial planning should be developed further with regional co-management as a goal
• Removal of LVF should be encouraged through economic support to the fishermen and fish farmers
• Removal of nutrients in the form of LVF should be taken as a compensation measure as one possible part of the aquaculture permits
• All management tools should be encouraged through planned incentives and by avoiding obligatory rules or enforcement because of the danger posed to profitability
Thank you for your attention

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