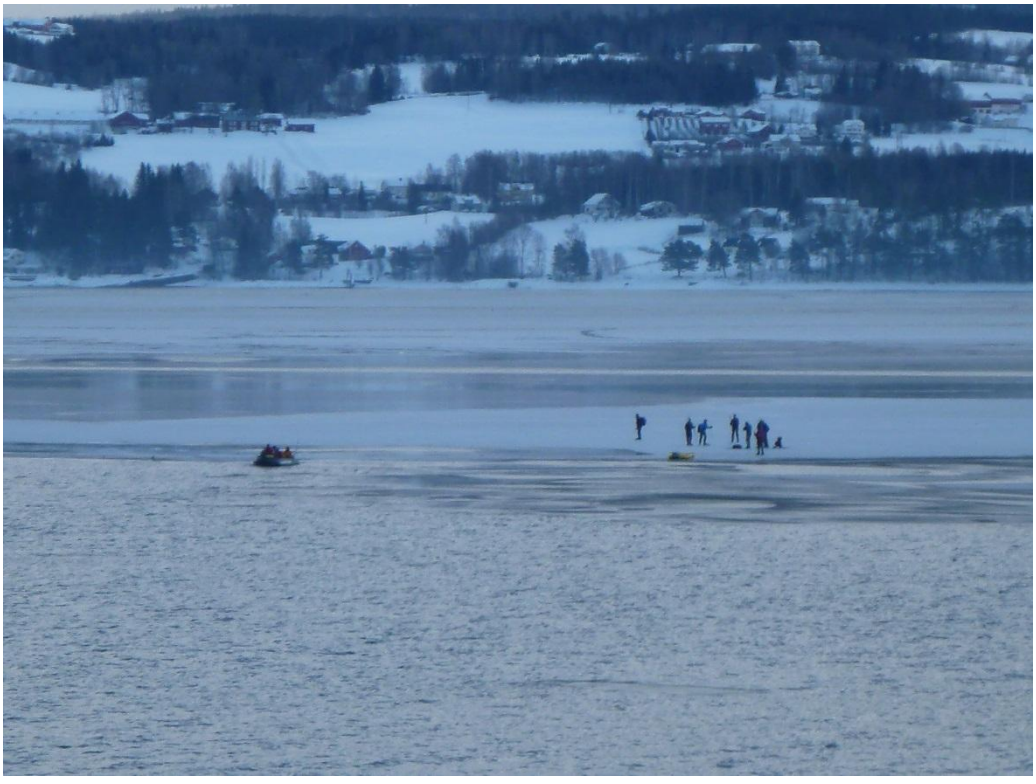
The Mjøsa Incident

February 7, 2015

Incident Analysis



Abstract

The purpose of this investigation is to learn from the experience and suggest how involved clubs can develop their safety routines and support their leaders so that tours will be safer and better in the future.

The prospects for a multi-day tour were unfavourable with severe winter weather, snow-covered lakes and absence of fresh ice reports. The study shows that individuals affected the chain of events but also that these individuals were part of a larger context and influenced by several causes on an overhead level, mainly deviation from current practices and lack of communication. The longing for exciting skating outweighed routines that the clubs involved normally carry out during planning and skating.

There was a limited knowledge of how ice usually behaves on this particular part of lake Mjøsa. Risk assessment of drifting ice was not performed. Even if such an assessment had been made it would have been a big challenge to hold back the group from skating on the inviting black ice on lake Mjøsa the morning in question. The path the groups chose took into account prediction of ice thickness and coming wind. Choosing other paths might have resulted in far worse ice drift and rescue scenarios. Key activities during critical phases show that adequate safety equipment and skills prevented participants from being injured. An early alarm call was admirably made. Rescue and medical personnel had adequate equipment and behaved very professionally.

The report suggests two main measures to improve safety and reduce risk in organised skating. One addresses awareness, attitudes and values concerning ice drift and serves to make individuals aware of ice drift risk, of risky behaviour and of ways to reduce risk by. The other involves developing a manual for multi-day trip management to be used by the clubs involved, and serves to support planning, carrying out and evaluation of multi-day tours.

Contents

Commissioned by

Anders Norr, Chairman of Linköpings Långfärdsskridskoklubb (LLK), on behalf of the involved clubs LLK, Hollandse Langetocht Schaats Klub (HLSK) and Bråvallaskrinnarna (BSK).

Start date

An analysing team is proposed and collection of facts begins February 8, 2015.

Reversal date

The Mjøsa incident report will be given to the commissioner November 29, 2015.

1. Assignment

The purpose of the study is to learn from the experience and suggest how involved clubs can develop their safety routines and support their leaders so that the tours will be safer and better in the future.
The main goal of the authors of this report is to learn as many lessons as possible from the incident. The report is written from a club (LLK, HLSK and BSK) point of view and is meant to address safety issues only.

1.1. Members of the analysing team

Team leader: Arnold Solmar, Linköpings Långfärdsskridskoklubb, LLK
Krister Valtonen, Linköpings Långfärdsskridskoklubb, LLK
Ronald Cornet, Hollandse Langetocht Schaats Klub, HLSK
Jan Angner, Bråvallaskrinnarna, BSK
Johan Porsby, Stockholms Skridskoseglarklubb, SSSK

Additional proof reading and language corrections were made by Lotta Fischerström, LLK

1.2. Methodology

The skridsko.net with written tour reports, pictures, videos and GPS tracks has provided detailed information about the event chain.
GPS tracks have been simultaneously analysed with Google Earth and a video has been produced.
All 12 leaders acting on Mjøsa have been interviewed.
Participants have given information through questionnaires and shared photos and videos.
The Norwegian Weather Service (Meteorologisk Institutt) and Road Authority (Statens Vegvesen) have supported with weather statistics. Norges vassdrags- og energidirektorat have provided basic information about lake Mjøsa.
The Gjøvik Police has been contacted regarding the rescue and helicopter operation.
Other persons with knowledge of skating and of lake Mjøsa have also been contacted.

2. Result

2.1. Prior to the incident on Mjøsa

The actual incident on Mjøsa was preceded by some distinct circumstances, which can be briefly described as:

- Linköping is the point of departure - and also the hub in the search for skateable ice.
- The weather situation is very difficult and there is great uncertainty if skating areas can be found at all.
  Prerequisites for skating are diametrically positioned against the high expectations of the participants.
- The first day of the multi-day trip offers minimal skating on the Swedish West Coast on areas with very thin ice. The group has high expectations for nice skating, and the search for skating areas goes on frantically.
- The high-level skating experience on lake Øyeren on the second day becomes redemptive. The wish for new lakes is nevertheless stronger than the wish to remain at Øyeren for one more day.

The Organising Committee considers risks and opportunities. They take into account that the return journey to Linköping should be of reasonable length and offer a skating opportunity. To leave a skating area where conditions are known, such as at Lake Øyeren, in favour of a new, more unexplored setting, implies an acceptance of greater risk.

Why this inclination toward higher risk acceptance? Several factors contribute. One is the euphoria created by the skating on Øyeren. Another one is the build-up of expectations for a good

skating experience during a tour involving visits to several lakes. The risk also increased because of the urgency to arrange overnight accommodation after the day at Øyeren. The situation is well in line with the concept of *choice shift*, meaning people in the group make decisions that are more extreme compared to the choices each member might have made on their own. In making decisions there is a mechanism where people observe and evaluate the group values and preferences. In order to obtain acceptance decision-makers take on a position similar to others but somewhat more extreme. By doing so, a person supports group perceptions, while presenting him/herself as a formal or informal group leader.

Prior to skating on Mjøsa the organisers have difficulties finding leaders for all groups, and some leaders are appointed late. In addition, access to the Internet is severely limited which means leaders' preparations are weaker than normal.

It is interesting to try and understand how the negative consequences of higher risk acceptance can be counteracted. Research suggests that well-established groups suffer less polarization, as do groups that deal with problems familiar to them.

To the above may be added inadequate communication on all levels: from organisation to leaders, as well as between leaders/organisers and participants. Ambitions and routes are not clearly articulated. Good communication is a central feature of group processes that function well. On a basic level, all involved should understand each other, both in terms of verbal and social communication, and have common goals.

2.2. The incident on lake Mjøsa

The skating on Mjøsa begins on a magnificent morning with wonderful black ice. This observation in itself (isolated from all other observations) raises high hopes of a great skating day. However, there is a pattern of conditions that have not been identified or observed collectively by anyone. Probably all conditions were observed but not connected.

- The area south of the starting point is known to be ice border toward open water
- The ice is not connected firmly on the eastern shore of the initial planned skating area
- Skating area thins out toward open water and in the future direction of the wind
- The skating area outside the Hunnselva outlet in Gjøvik is marked as hazardous in Norwegian lake information
- A strong weather change is anticipated at noon, in such cases there is always an uncertainty about the time and scope
- Lake Mjøsa has a large volume relative to its surface and is regulated in terms of water level

The paths the different groups took were a result of previous days' ice reports. As a safety measure the leaders were cautioned not to be on the central lake area around noon when the wind and temperature increase were predicted to arrive. If the groups had chosen paths close to where skating had taken place the previous day, a much worse scenario might have evolved, with groups ending up on much thinner, drifting ice, further away from rescue teams. Under such

circumstances boat rescue (such as the one performed) could even have been impossible to carry out due to blocking ice floes.

There is no single clear critical event that could have held back the skaters that were subjected to ice drift. Generally, however, the gradual increase of risk could have been reduced had the clubs more rigorously followed normal procedures for planning and tour leadership. It would have created a decision situation where it had been easier to question the choice to skate close to Gjøvik. If leader briefings had been carried out according to practice, both the evening before the incident and upon entering the ice on Lake Mjøsa, alternative routes could have been considered. For instance, someone might have suggested an initial route further north on an older generation of ice, not entering the relatively new black ice until after the predicted weather change.

When the ice starts to drift there are two groups on drifting ice. One of the groups has just decided to return to ice with more bearing capacity, while the other has just passed a section of thinner ice outside the outlet at Gjøvik. This type of routing is normal in tour skating. In assessing how these groups chose to go, the reward of skating on a nice ice surface is balanced against the risk of thin ice. The difficulty to weigh in, for example, the risk of ice drift means that the route is made almost entirely from ice thickness. To this can be added to the knowledge of the lake's characteristics were lacking.

Two of the other groups are at positions that do not drift initially. Their positions have been affected by safer choices, to move closer to shore after the warm air arrives. Still they are close to widening cracks relatively close to the shore.

Observing the unusual pattern of event taking place after the warm air arrives (i.e. the moment before the ice drift begins), the fifth group acts cautiously early on. The arrival of warm air, the appearance of the ice with convex portions, and difficulty to interpret the situation, cautions them to move toward security closer to shore. The decision to go closer to shore and stay there to consider a continued skating route is an example of defensive tactics in an uncertain decision situation. Worth mentioning is that even this position, although considered safe, is close to a widening crack.

Decisions and activities that take place on the drifting ice are crucial to the safe ending of the incident. The leaders successfully achieve their objective of gathering all the skaters on safe ice areas, although it involves some drama. The more dramatic parts involve the crossing of opening ice cracks and the use of lifelines. To this should be added an admirably brisk alerting of the emergency services from one of the groups on shore. Rescue personnel contribute with a professional conduct, which induces calm and security. A piece of equipment worth noting is the aft-less dingy used for evacuation from the ice floe to the larger lifeboat.

As a summary, not in priority, it is noted that:

- Weather and ice situation is extremely uncertain for skating even before the multi-day trip started
- Participants have strong expectations which contribute to a high risk behaviour

- An overloaded organization team both plan, organise and carry out the multi-day trip, while also acting as leaders on the ice
- The organisers feel pressure from the participants
- Leader briefings, especially on the evening before skating on Mjøsa and on entering the ice, are not implemented. There is no clear structure for such briefings. Communication suffers.
- Leaders are enrolled with short notice giving hardly no time for tour preparation
- Access to the internet is limited, especially the night before the tour on Mjøsa
- Weather information was collected from yr.no and smhi.se webpages but the weather forecast on Norwegian television showed a better overview of the whole weather situation.
- Traditional printed maps of Mjøsa are missing, tourist maps provided by the hotel were used instead
- Leaders and participants have little experience of Norwegian lakes
- Knowledge of drifting ice risk pattern is not taken into account
- Prediction of drifting ice risk is difficult
- Alarm call is made early providing time for rescuers to act properly
- Safety issues, such as life line attachment and throwing, need to be addressed, checked and trained

2.3. Proposed actions

The questionnaire that virtually all participants have answered provides 158 suggestions for improvement for future multi-day trips. These proposals can be grouped into five main areas:

- Organising Committee
- Leader
- Communication
- Group Dynamics
- Participant

With regard to these proposals, the analysing team proposes two measures for the three clubs to implement:

(1) An activity to improve awareness, attitudes, and values regarding ice drift risk. At planning and execution of tours, this risk should always be assessed and taken into account along with other risks.
(2) Develop a multi-day trip manual on how to prepare, implement and evaluate a multi-day trip.
These two prioritized activities take into account proposals from the participants. They also reflect the general conclusion of the analysis team on the basis of the chain of events. The safety officers in the clubs involved may on request use the 158 anonymous proposals in their work to continuously improve safety.
See also further details in chapter 8 Proposed Measures.

3. Chain of events

During the International Ice Congress on January 21-22, 2012, in Turku/Åbo (Finland), representatives from the sister clubs LLK and HLSK met and decided to arrange multi-day bus trips with participants from both clubs as a way for members from both clubs to meet and enjoy skating together. The first bus trip was made on February 14-17, 2013, with skating on the Swedish West Coast north of Gothenburg and on Lake Mjörn. The trip was successful. The date for next trip was set for February 5-8, 2015.

The planning of the trip was very difficult due to heavy snowfalls in late January and early February, which covered most parts of southern Sweden [SMHIjanfeb2015]. Areas considered were Växjö, Bohuslän and Värmland. One person in the planning committee had over 600 e-mails related to the planning of the trip [Questionnaire]. Finally Bohuslän was selected.

3.1. Thursday February 5

Participants from Holland and Germany have arrived on the days before. The bus with 45 people leaves Linköping at 06:00 a.m.

The first stop is Sannöfjärden. The ice is tested but found too thin and injected with snow. The ice close to the boat moorings is dangerous. It takes very long time for some participants to accept this and get them off the ice. There is no leader taking a strong leading position to have a safe ice assessment and procedure to enter on ice. Two more stops are made, at Nedre Bolsjön and a small area close to Älgö at Inre Tjärnöarkipelagen, were very small areas of ice were skateable. [SN5feb]

Sannöfjärden. The ice is too thin for skating.

Thursday evening the planning for the next day's skating is done. When analysing satellite pictures one of the leaders find that there is a good chance for skating on the Norwegian lake Øyeren, east of Oslo. Not far from Øyeren is Mjøsa, which also may be good for skating. Some people in the planning committee want to go to Runn and Siljan in Dalarna (Sweden) instead. A decision is made to try Øyeren, with Mjøsa as plan B. Maps for both Øyeren and Mjøsa are printed. The desire to skate on Øyeren/Mjøsa versus Runn/Siljan divides people in the planning committee and leaders. Those that would have preferred Runn/Siljan accept the decision, but become more passive in the planning.

3.2. Friday February 6

Øyeren appears to be good for skating and four groups make between 37 and 58 km of skating on the lake.[SN6febØyeren]

Lake Øyeren February 6

Toward the end of the skating tour on Øyeren and in the bus, some leaders and participants discuss options for the next day. Some still prefer Siljan, while others want to skate on Mjøsa. Reports from Dalarna and Siljan indicate little ice growth and limited skating, which is to the disadvantage of this option. A discussion topic up front in the bus was also the risk of ice drift on Siljan, which was considered quite high. Participants noticed that other persons had discussed this on the Internet on Friday evening. The alternative to make a bus drive to lake Siljan after skating on Øyeren would have been more time consuming than travelling to Hamar by Mjøsa. Also the trip back to Linköping would have been longer from Siljan. The desire from many in the group to skate as much as possible creates a strong interest for Mjøsa. Hamar also offers reasonable accommodation. A person in the organizing committee takes responsibility for booking accommodation. A decision is made to stay overnight in Hamar. The reason to choose Hamar instead of the lake Siljan is not communicated with clarity. An additional day's skating on Øyeren would also have been possible, but the desire to try a new lake prevails.

Friday evening in the hotel at Hamar, communication between participants is hampered by a crowded dinner area with bad acoustics. Many participants prioritise socialising with other skaters. Some leaders and one person in the organising committee are not feeling well and go to bed early. The pressure to organise leaders for Saturday's groups falls on one person in the organising committee. The search for leaders, which started already on the bus from Øyeren, continues during the evening. Definite acceptance from some leaders is not given until on Saturday morning. The leaders do not gather to exchange information at all Friday evening, even though some requests a gathering.

The Internet connection is very bad and many have difficulties finding weather information and reports from other skating trips on Friday. One of the organisers has problems with a new computer, which makes information search more difficult for him. A skating report from the west arm of Mjøsa on Friday reports very good ice.[SN6febMjösa] One can see where the group has skated, but it is unclear why they have not skated further southeast. A phone call is made to one of the participants, but the questions to the person are unstructured and the call does not provide any additional information. The weather is discussed to some degree and information is collected from the yr.no and smhi.se web pages. yr.no reports increasing wind at 12 o'clock noon. Handwritten scales are written on the maps of Mjøsa that were printed Thursday evening.

The organisers expect the leaders to take responsibility for seeking lake information and weather forecasts, but this is not clear to the leaders. Some leaders expect the organising committee to feed them with information.

3.3. Saturday February 7 – before the ice drift

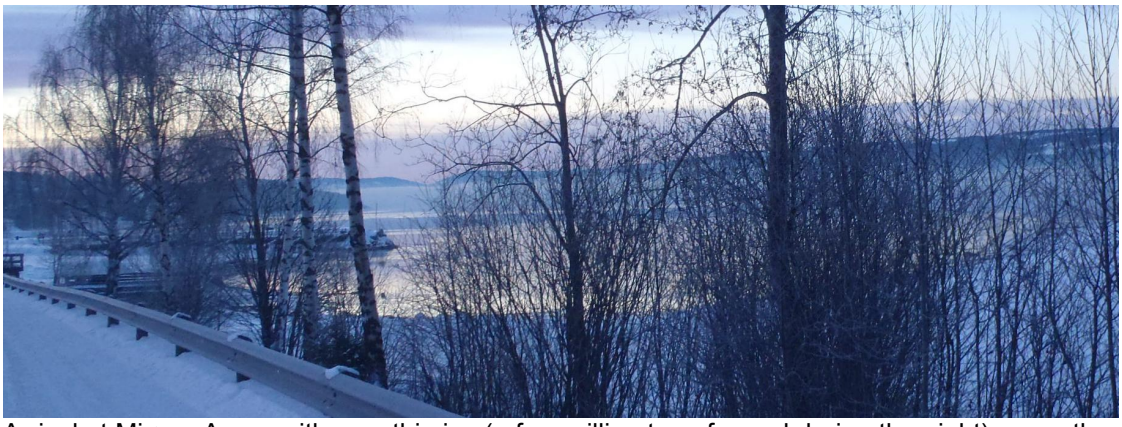
The leaders are asked to sit together up front in the bus, and they exchange phone numbers with each other and with the bus driver. Tourist maps provided by the hotel are distributed among the leaders. The leaders have a common plan to skate southwest first and then head northeast well ahead of the predicted increase in wind, which is expected around 12 o'clock noon. No other

information is shared between the leaders. During the driving to the starting point the bus thermometer drops down to –13° C at the lowest.

A skater observes that the boat moorings (T-bars) at a port are pointing down and suspects that the lake is heavily regulated. Another skater in the bus describes afterwards that he had no prior information on weather, wind, ice situation, etc.

The following event chain is also shown on video on YouTube showing the coordinated movement of the groups and some film sequences from taken by participants in the groups. [https://www.youtube.com/watch?v=DB9iDt7pjQg]

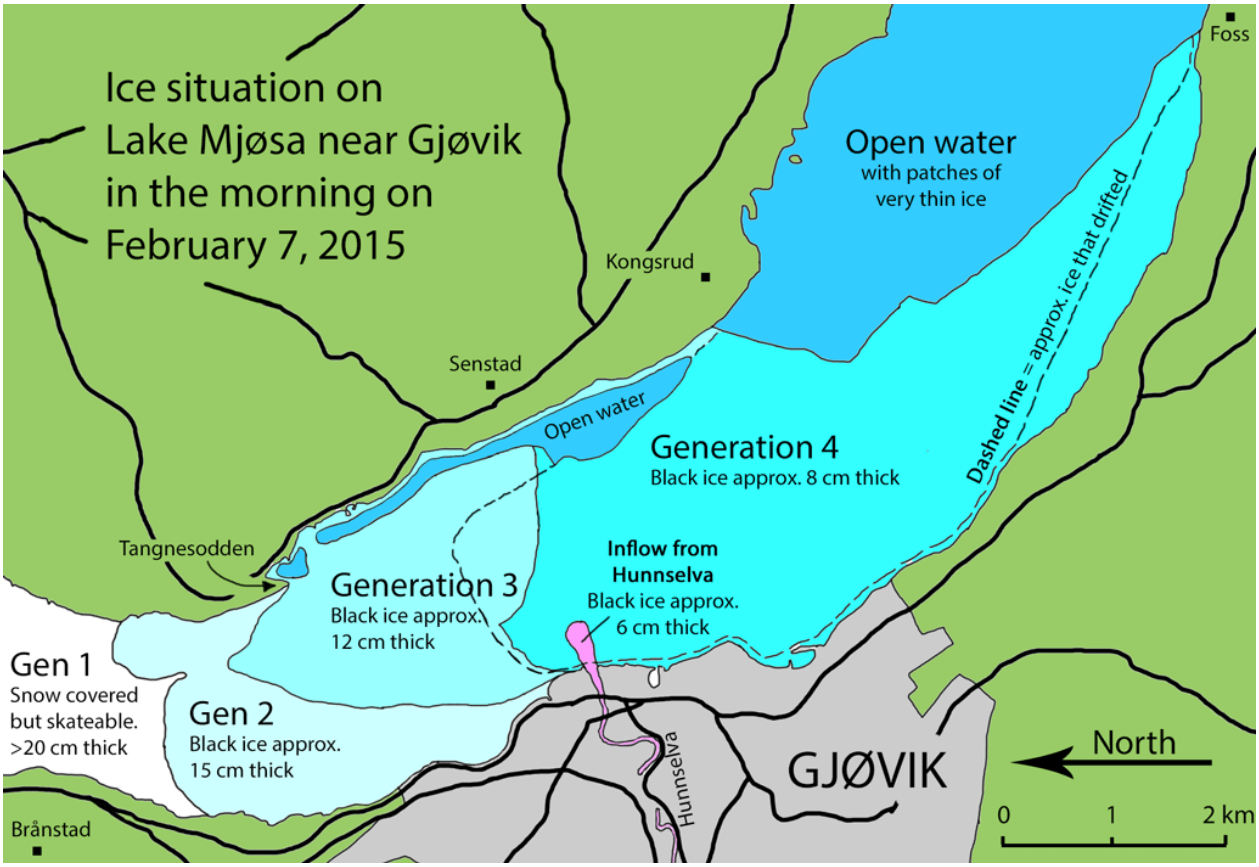
Upon arrival at Mjøsa the bus driver is searching for a suitable place to drop off the skaters. Two persons, one leader and one participant, gets off the bus before the others and step down on the ice to check on ice conditions. From the bus, several participants observe that the ice is pressed down slightly around the two on the ice as they are skating. The two persons checking the ice notices that there are openings or very thin ice along the northeast side of the lake. The open area / thin ice stretches far south. They manage to get out on the lake and conclude that the ice out on the lake is good for skating. The bus, carrying the rest of the people, continues to search for a suitable drop-off place and stops at Tangnesodden where the ice is thicker. The bus thermometer shows -4° C when the skaters leave the bus. There is practically no wind at all.



Arrival at Mjøsa. Areas with very thin ice (a few millimetres, formed during the night) on northeast shore and fog far south.

The organisers advise on a path down to the ice well before some houses at the tip of the Tangnesodden headland. The majority of the participants pay no attention to this, however, but continues to the houses and then down on the ice. Some people urinate by the houses. Someone catches a glimpse of angry-looking people behind the windows.

On the ice people are getting their gear in order and leaders and participants check the ice. The ice is very good at the starting point, more than 10 cm thick black ice. With the sun rising and a cold morning many have high expectations. The ice situation in the morning in the area is shown below.

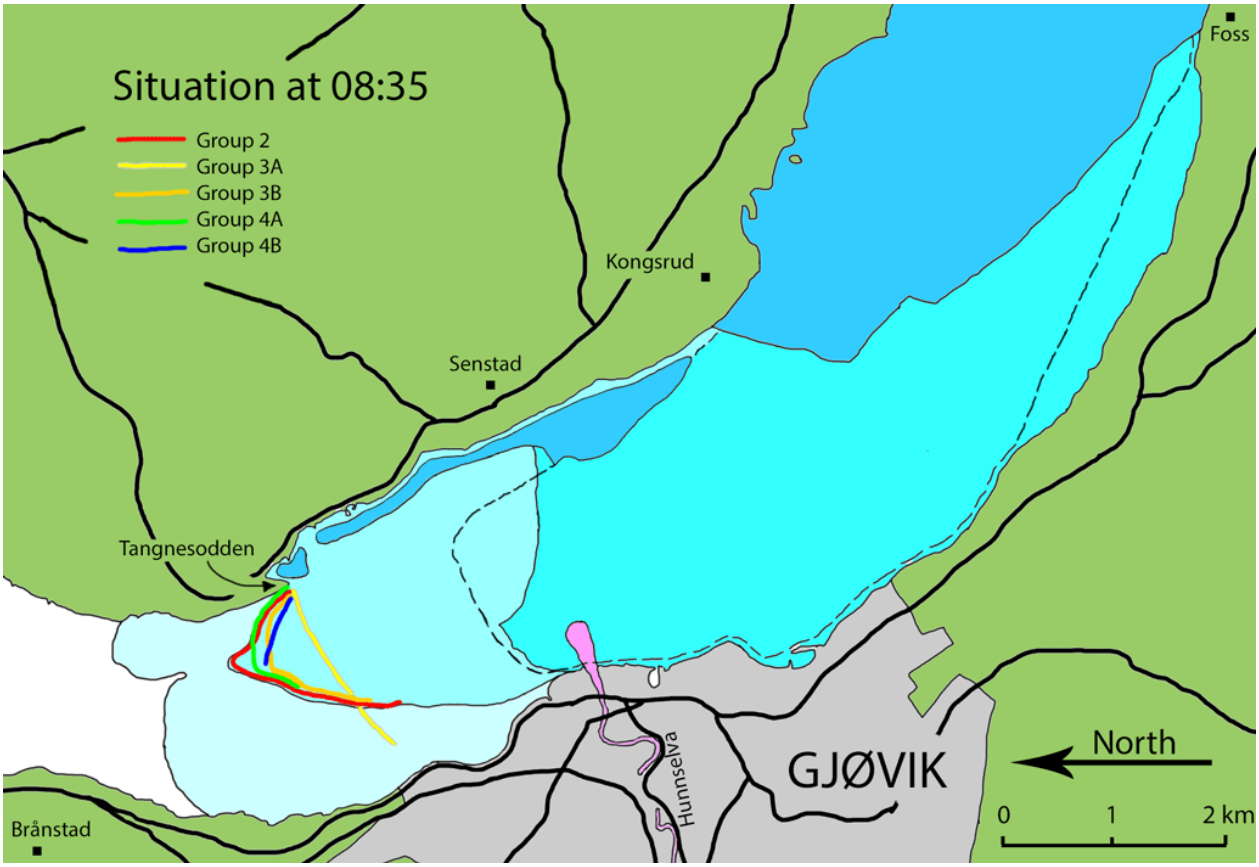


Five groups are offered and participants choose which group to skate with. All groups have two leaders, one up front and one at the tail of the group. In one of the groups, the leaders choose to skate as first and second person, assign the queue to a third person. A few groups organise a gear check in pairs. No gathering of the leaders for ice discussion and general planning before skating takes place.

The groups are (group numbers indicate skating speed, with lower number = higher speed)
Group 2 – 14 persons
Group 3A – 9 persons
Group 3B – 7 persons
Group 4A – 7 persons
Group 4B – 8 persons

Before start the participants have very vague ideas of weather forecast and ice conditions, if there is open water, etc. One leader consciously chooses not to give detailed information to his group so as not to raise expectations of route and goals. Another leader gives a very brief description of the planned tour. One leader (the one who noticed the angry people at the house and who feels ashamed of the “trespassing”) departs leaves the starting point early with his group. One skater experiences the start as fast without a detailed introduction from the leaders. Some perceive that the tour will be finished at 14 p.m., others at 15 p.m.

The groups depart around 8:30. Some groups choose to go northward, against the wind, while group 3A choose a shorter route across the lake to reach Gjøvik faster. Some participants think the atmosphere is somewhat different from on a conventional LLK tour, in the sense that expectations are higher. The skating speed is perceived in most groups as moderate. One skater, checking the ice with the ice stick, cannot get through the ice with one hit at any point on the journey across the lake.



All groups make a short stop on the way over to Gjøvik. Most people, but not all, experience a sudden increase in air temperature. Some people need to take off some clothes during the stop. One skater notices that the ground wind is different from cloud movement. Someone experiences increasing wind after the arrival of warm air. Another person feels the warm air like a down wind. In one group a participant suggests the group turn northward to skate against the wind in the beginning of the tour, but the proposal is not adopted.

One participant (member of group 2) who checks the ice early on, pictures the overall situation: big lake, new ice, ice loose from the eastern shore, a border with old ice, and a weather change coming up. He tells the leader during the stop to be close to the shore. The leader interprets it as a warning signal for an unknown situation, whereupon he chooses a more direct path towards the western (Gjøvik) shore.

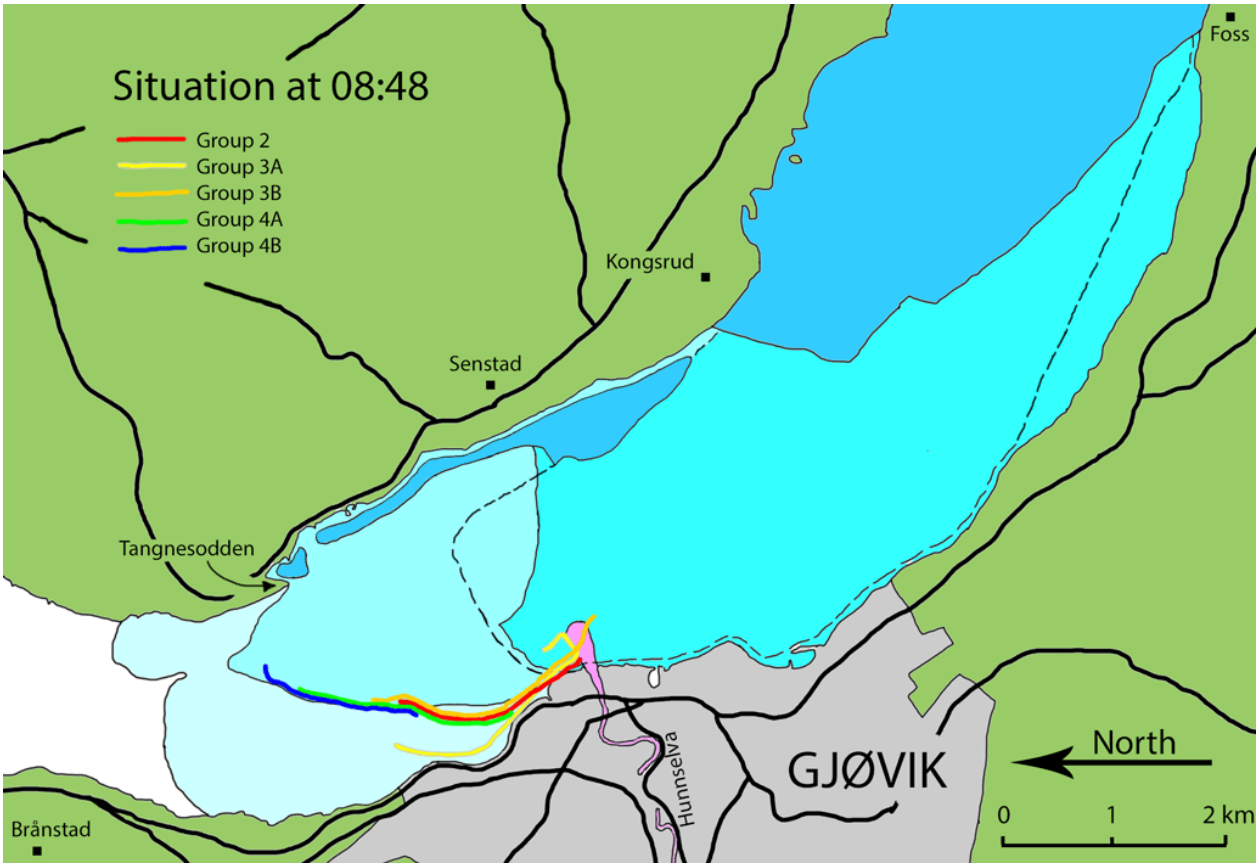
The leader of group 4A listens to the group reasoning about a possible weather change and, as a result, chooses a new travel direction more rapidly towards shore.

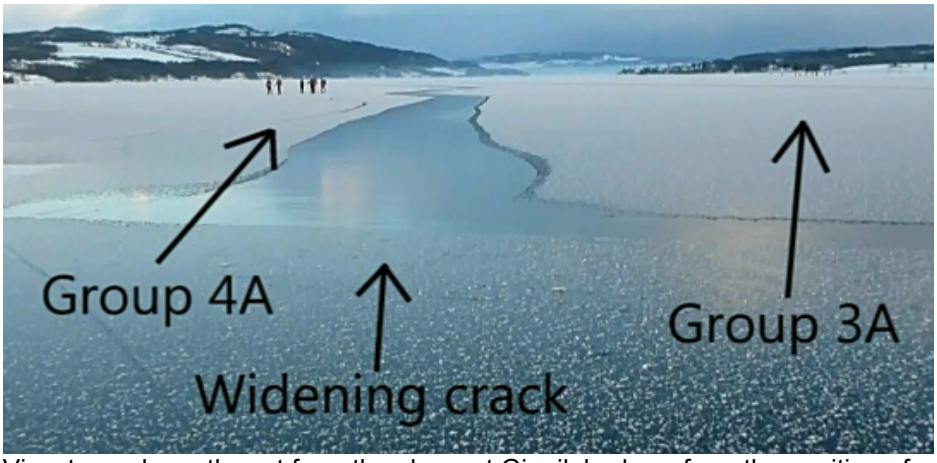
On the way to the inflow from Hunnselva some persons observe an unusual pattern of the ice surface, with stripes of convex ice.

3.4. Ice drift

Group 3A is the first to reach the inflow from Hunnselva. The leader tries to skate around the section of weaker ice just outside the harbour. After a few tries, the leader abandons the idea of going further south and turns north instead, but without going back to the shore. Group 2 stops at the inflow to overview the situation. The leader for group 2 still feels uneasy about the situation. Group 3B, arriving to Gjøvik just after group 2, passes group 2. The leader for group 3B sees the inflow from a river and takes his group further out in the lake. Increased distance is signalled to the group. Some 100-200 meters south of the inflow the ice becomes thicker and more stable. The wind is now about 3-5 m/s from the west. At this time, 08:48, the ice starts to drift.

Some people hear a loud bang; “like a shipping container being dropped on the ground”, as one person puts it. Another one notices snow and small pieces of ice jumping up from the ice, “like bread crumbs that fly in the air when you hit a table hard with your hand”. Some people do not notice anything special. Group 2, being very close to the shore, manages to jump over some widening cracks and position themselves on the safe side of the cracks. At this point, groups 3A and 3B have not yet realized that they are on drifting ice.

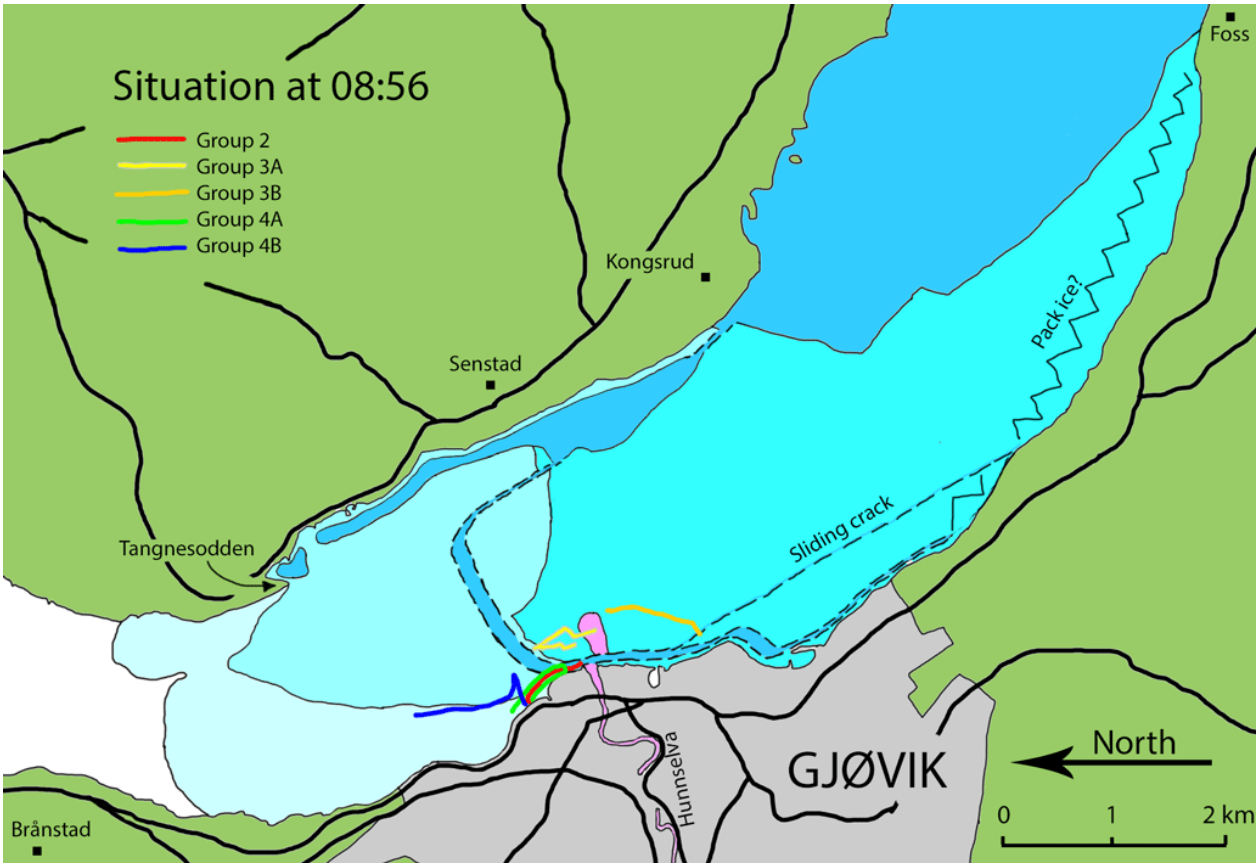




View towards northwest from the shore at Gjøvik harbour from the position of group 2. Photo taken only a few seconds after the ice drift started.

Group 3A continues north but faces open water. They turn south. Groups 2, 4A and 4B meet by the shore and blow their whistles towards group 3A to alert them of the danger. Group 3A hears the whistles but has already realised the danger. When group 3A reaches the spot of ice which a few minutes earlier faced the inflow from Hunnselva, two persons fall into the water as they try

to step over some cracks. When group 3B slightly later reaches a “sliding crack” (ice is mostly sliding along the crack with only a slow widening) they realize they are on drifting ice. Stepping over the “sliding crack”, they try to find a way to shore as quickly as possible. The clock now shows 08:56.



In group 3A, where the two persons just plurred, three skaters end up on the wrong side of an open crack. The three are asked to lie down and grab the lifelines thrown to them, by which they then are pulled across the crack. Thanks to this rescue operation the group is gathered again and continues skating south.

Skating as number one and two, the two leaders of group 3B keep discussing available options during the search for a safe way to shore. After criss-crossing over a number of smaller cracks, they eventually reach two several meter-wide open cracks which block the passage towards south and west, forcing them to give up the search. Backtracking in their old tracks, they turn north towards group 3A. The two groups meet, both believing/hoping the other has a safe way to land, which is not the case.

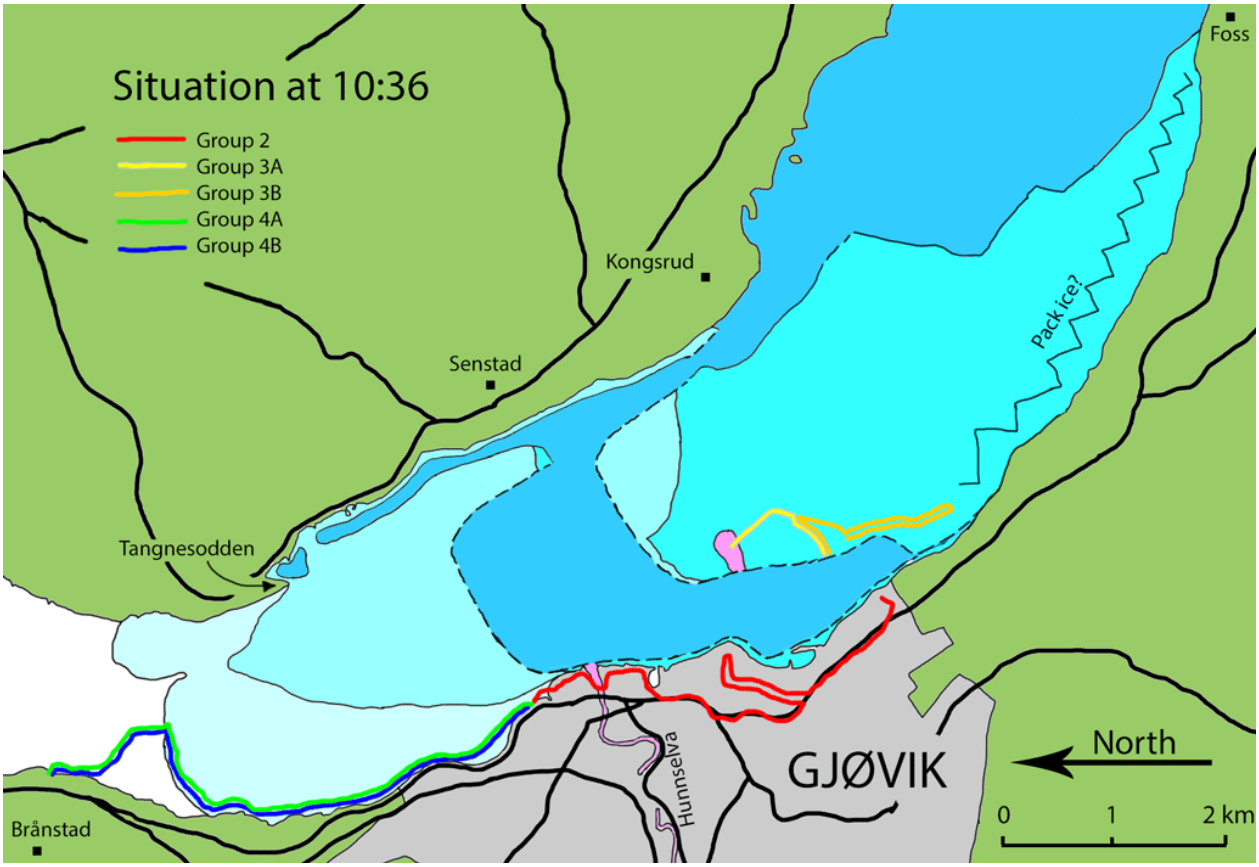
Meanwhile on shore the group 2 leader, observing the two group 3A members falling into the water, dials the emergency number 112. Group 2 decides to stay and assist in the rescue of groups 3A and 3B. Groups 4A and 4B, feeling they cannot perform any useful activity, continue skating northwards along the shore. As they skate they observe some cracks, but no moving ice. They skate on an older generation ice and, later on, on snow-covered ice. The ice is considered safe.

Assuming there will soon be journalists to face, discussion arises in group 2 regarding who should act as media spokesperson. According to LLK guidelines, it ought to be a member of the board. But no such person is present in group 2. They decide to let the group 2 leader take on the role.

A policeman from Gjøvik is the first to arrive and is very troubled learning that people are far out on drifting ice and some have fallen into the water. Learning from group 2 that it is people who are experienced in rescuing themselves when falling into the water calms him. A helicopter arrives later and the leader for group 2 clearly instructs that a helicopter cannot be used in the rescue, a lesson learnt from the Askö incident.[Askoreport2003]

In groups 3A and 3B, out on the moving ice floes, the participants experience various confidence in their leaders. As the groups reunite, some difficulty with leadership communication occurs. One of the leaders has strong stress reaction, and a new leader takes over. After crossing a few uncomplicated cracks, the groups find stable ice with a thickness of about 11 cm. One of the two who plurred changes into dry clothes. In conversation with the group 2 leaders, they learn that a rescue boat is on its way, and that the groups are ordered to stay put. Two leaders investigate the surrounding ice in order to find a good rescue-boat landing spot with a thick and stable ice edge good for multiple pickups. The groups observe a decreasing temperature and dark clouds showing up. The news of the rescue boat calms the participants and the situation starts to feel safe. The ice floe is slowly drifting SW with a speed of approximately 1 km/h.

Group 2 walks on land southwards to keep an eye on groups 3A and 3B. The bus arrives, and group 2 enters the bus. They drive a short distance to the south for the pickup, but needs to reposition to a better place. Groups 3A and 3B reposition to the decided rescue-boat landing spot.



3.5. Rescue

There is some delay in getting the rescue boat into the water since the road down to the water is not cleared from snow. Approximately one hour after the emergency call was made the boat is in the water and the rescue operation can begin. Those who are most chilled and troubled are shipped ashore first. The shipping is done with a larger rubber boat, but a smaller inflatable boat without aft is used to transfer people from the ice floe into the larger rubber boat. As several participants point out, this solution works extremely well. The rescue staff from Gjøvik Brannvesen speaks English and appears relaxed, which is appreciated and facilitates the evacuation. Also, they are performing the job without putting blame on anyone. They have a very professional attitude.

One of several rescue transfers

The two last skaters to be rescued using a smaller inflatable boat without aft.

Groups 4A and 4B have a coffee break on the shore further north. In talking with group 2 over the phone, they follow the rescue operation. After the break they skate back south. The weather becomes increasingly unpleasant with a strong tail wind and hail. A police helicopter appears and forces the groups to the shore. Group 4B gets a ride with the police to the bus in Gjøvik.


Police helicopter gives “order” to get away from the ice.

On land it is found that everyone is safe and sound. The second person who fell into the water changes into dry clothes. Several media appear at the spot where people are coming ashore from the drifting ice. One person from group 3A participates in a video interview.

3.6. Debriefings

It is decided that the bus will travel to Karlstad in Sweden. Since it’s a long ride, a debriefing is conducted on board the bus. All who wish are invited to say what they want. A second debriefing is held in the evening during the joint dinner at the hotel in Karlstad.

4. Underlying causes

4.1. Difficulties in getting ice information

It was difficult to obtain relevant information on possible waters to skate on. Persistent snowfall over possible skating areas at a reasonable distance from Linköping, resulted in a minimal number of ice reports on skridsko.net. Satellite imagery gave very limited indication of frozen water or clear ice. There were fresh skating tracks from Mjøsa but no information on risk pattern.

4.2. Stressed organising team

A few days before the start of the multi-day trip, the tension increases regarding the selection of skating area. Opinions and suggestions are exchanged frequently within the organisation team as well as among participants. Organisational resources are reduced as one of the members of the organising team (for personal reasons) has to give up task. Following an optimistic report from an ice tracker, the organisers first settle for the Swedish west coast. When conditions there prove undependable, they face the challenge of finding a new better skating area. Speculations about skating in Norway or in Dalarna in Sweden create additional stress for the decision makers.

4.3. Pressure from participants

To participate in a multi-day trip meant for many (especially the Dutch) participants to take vacation, buy air tickets, stay at a hotel before departure, etc. That is, financial sacrifices. The participants generally have an experience of amazing ice-skating on natural ice in Scandinavia. Several had participated two years ago and experienced a pleasant companionship with skaters from other clubs. Overall this created strong expectations for new experiences. These expectations were communicated among participants as well as to the organisation team.

Since the multi-day trip date was fixed and decided long beforehand it was not easy to cancel or postpone the trip to a later date. This fact added to the stress on the organisation team.

4.4. Club policy shortcuts

The group dynamics develops two distinct features:

- The Dutch club's rigorous methodology for planning and implementation of multi-day trips is not followed.
- The Swedish club guidelines for day trips are waived on certain details: most significantly on leader preparations and the eye-to-eye checking procedure.

Overall, there is a situation of increased risk pattern, both because of the underlying reasons mentioned above and because of a deviation from the clubs' normal procedures for planning and safe management of tours. To summarize, there are strong expectations for fine skating experiences. At the same time a tendency to "follow others" arise, in the belief that others know what they are doing.

4.5. Ice drift

Ice drift is a risk when skating on big lakes, streams and the sea. On most of our skating waters, smaller and island-rich lakes, the risk of ice drift is however small. Therefore it is easy to overlook this risk in other waters. In addition to Mjøsa, ice drift was reported at Ånnsjön, Kolbäcksån and Siljan during the season 2014/15. To assess the risk of ice drift is difficult. Often the ice drift starts suddenly without warning. But there are some warning signs to consider:

- Great lakes and water close to the open sea
- Large areas of thin ice
- Wind
- Weather changes
- If the ice is broken into floes
- If there is open water in the direction the wind blows

To enable ice drift it takes something to first break up the ice into fields (or floes). When an ice floe is detached, very little wind or current is needed to get the ice in motion. At sea it is common that waves break up the ice into fields or floes, which then drift away. This can also happen on the large lakes, such as Vänern and Vättern. Wind alone can also break up the ice. In rivers the current from water flow can create drifting ice floes. Often sudden changes in weather trigger a breakup of the ice, a wind shear, a water level change, or a sudden change in temperature that can make the ice crack.

<u>The incident on Mjøsa</u>
How could the ice outside Gjøvik so quickly break up and start to drift? An important factor is most likely the sudden change in weather. Probably, the change in temperature created tension in the ice causing the ice to crack up, but air pressure change and changes in wind strength and direction might also have played a role. Some skaters noticed a change in the ice surface and in the sound from the ice when the warm wind arrived, which could indicate tensions in the ice.

The quick breakup and drift of the large ice floe came as a surprise to most skaters. Even if Mjøsa is a large lake, the section outside Gjøvik is quite narrow (approx. 3 km shore-to-shore). One might think that this is enough to keep the ice in place. But observations from skaters the day before indicate that there was no ice next to land along the northeastern shore between Mengshol Brygge and Smedstua. Combined with the lack of ice in the southeast (towards the central lake), it could explain how the ice quickly could begin to drift once it was detached from the ice connected to land near Gjøvik.

Why there was open water/thin ice along the northeast shore is not obvious. There are no major water inlets there. One explanation could be upflow of warmer deep water caused by wind or by current in the lake. We have not managed to get any information saying this area typically has thin ice.

On the day of the incident, there were a number of warning signs. Generally, extra caution applies on unknown waters. Mjøsa is a large and very deep lake with high throughput and large

fluctuations in water level. Under such circumstances, it takes a long time for ice to build up. It rarely happens that the entire lake is covered with solid ice. The lake is surrounded by high mountains, which increase the risk of rapid weather changes.

The weather forecast for the tour warned of very strong winds, and of storm in the mountains west of Mjøsa. Wind forecasts for Mjøsa were fairly modest. The weather report on Norwegian television in the program “Dagsrevyen” [Dagsrevyen20150206] showed that the weather front would pass in the morning and warned for wind gusts. It is possible that watching this weather report could have given better understanding of the weather change and helped in predicting the ice drift.

Thin and freshly laid ice is another warning sign, as is the fact that the central parts of the lake were still open.

What may have obstructed the risk assessment was that wind forecast for Mjøsa was fairly modest and that the lake near Gjøvik is fairly narrow. The unawareness of the ice not being fixed firmly in the northeast may have given the impression of ice well fixed to land.

It seems that the area outside Gjøvik is particularly exposed to drifting ice. This is what we have learnt when discussing with people having knowledge of the lake. The picture below shows a satellite picture of the ice situation on Mjøsa on almost the same day of the year but two years earlier. The whole lake is ice covered with snow on the ice, except the area that drifted during this incident. It would be very good to perform research on why this area is exposed to drifting ice, more than the rest of the lake.

Some other reports of ice drift during 2014--15

Ånnsjön

Ånnsjön is a popular skating lake in Jämtland, west of Åre. The lake is not known for ice drift. During a tour in November 2014, only the shallow northern part of the lake had ice. Three skaters ended up on an ice floe near the lake's outflow. Probably waves from the open part of the lake caused the ice to break up. Wind and currents could then put the ice in motion. The three were able to rescue themselves as opened cracks later shrank.

Kolbäcksån

Kolbäcksån (aka Strömsholms canal) is one of the larger inflows to lake Mälaren. While skating around Christmas a large amount of ice floes suddenly shoved at high speed under the ice. Shortly thereafter a raised water level was observed, which made it difficult to get ashore when the coastal ice was under water. No skaters ended up on the drifting ice, but many had difficulties getting back to shore when the ice was flooded.

Siljan

The day of the incident on Mjøsa, many skaters went to Lake Siljan, which was basically the only water with skating possibilities in Sweden at the time. The lake was completely covered with ice. In the strong wind, sometimes measuring gale force, an ice floe (approx. 10 by 3 kilometres) in the northern part of the central lake broke up. That area had thin ice about 5 centimetres thick. No

skaters ended up on drifting ice, but some were forced into long country walks then the intended route disappeared. The following Wednesday 10 skaters were rescued by boat from drifting ice in the western part of the lake. The next weekend, with winds turning from north to south, most of the remaining ice on central Siljan disappeared in a modest wind.

Risk of ice drift

To assess the risk of ice drift is difficult. We know that the risk of ice drift is very big on the central sections of lakes Vänern and Vättern. There ice drift is the rule rather than the exception. Along many stretches of coast, where there are no protective islands, the risk of ice drift is also large, especially in combination with waves. The risk increases if there is thin ice and open water nearby, especially when the wind is blowing toward open water. Weather changes, change in wind direction and velocity, air pressure changes and fluctuations in water levels are often associated with ice drift. Areas close to boat traffic are also prone to ice drift.

5. Secondary findings / second detected risks

It turned out that some participants had no experience of skating on natural ice in Scandinavia. This became a serious safety risk and an increased risk of injury when areas with broken ice and open cracks had to be traversed.

Not all participants had practised throwing lifelines. Emergency situations do require an ability to manage and throw a line. It is also essential that the lifeline and its accessories be properly attached to the backpack.

6. Proposed measures

The proposed measures aim both at individual participants and at organisers of multi-day trips.

The influence participants have on the chain of events can be attributed both to attitude and values. Especially during this multi-day trip, there was a wishful image of fascinating skating, which could hardly be based on conditions at hand. The measure (1) aims at making individuals aware of ice drift risk, of risky behaviour and of ways to reduce risk.

Even the organisation, i.e. the organising committee, is under the influence of values. Among the values is the target image of finding new lakes with exciting ice. To have a target image is of

course commendable, but it must be balanced against the risk, especially under uncertain conditions such as the ones that were present during this multi-day trip.

Overall, good example, attitudes and values should be highlighted, regarding risk behaviour and risk reduction, among both participants and organisers. Furthermore, participants and the organising committee should use methods and materials that support the preparation, implementation and evaluation of multi-day trips.

So far, between incident and reversal date of this report, no measures have been taken, except for debriefings and a questionnaire distributed to multi-day trip participants. Information meetings have also been held within the involved clubs.

ID	What	Details	Responsible	When ready
1	Attitudes and values regarding ice drift	Improve ice drift awareness: A) Distribute Chapter Ice Drift and information about previous ice floe incidents to leaders in involved clubs. B) Make Chapter Ice Drift and information about previous ice floe incidents available to members of involved clubs via club homepages. C) Give Internet link to article on homepage in club newsletters.	A) Head of leaders B) Home page administrator C) Publisher of club newsletter	Before 2016-01-31

2	Multi-day trip management	Develop a manual to be used with involved clubs. Clear any differences in policies or rules, etc. between the clubs (harmonise any deviation). The manual shall at least cover A. How to prepare a multi-day trip B. How to manage and implement a multi-day trip regarding delegation, communication, technical equipment, C. How to handle upcoming deviations. D. How to evaluate a multi-day trip.	HLSK team. The team must make use of participants from LLK.	Before 2016-10-31

7. Work sharing

The analysing team has shared work and briefly this is described in the table below.

Team member	**Topics**
Team leader	Research, report model, writing and presentation of the report at various meetings
Other members in the team	Interviews, meetings, report writing, conclusions, illustrations, report presentation, spell check and language

8. Comments from the commissioner

8.1 Measures

The commissioner makes a request to the involved club to perform the proposed measures described in chapter 7. Measure 1 should be made before 2016-01-31 and measure 2 before 2016-10-31. Further on the safety officers in the involved clubs are encouraged to study the 158 proposals that involved participants have given. An anonymous compilation can be ordered from the team leader.

8.2 Feed-back

The incident analysing report should be presented to the involved incident participants. Additionally the report should also be presented to club members and leaders during the season 2015/2016. The report should preferable also be public at homepages of the clubs.

8.3 Monitoring

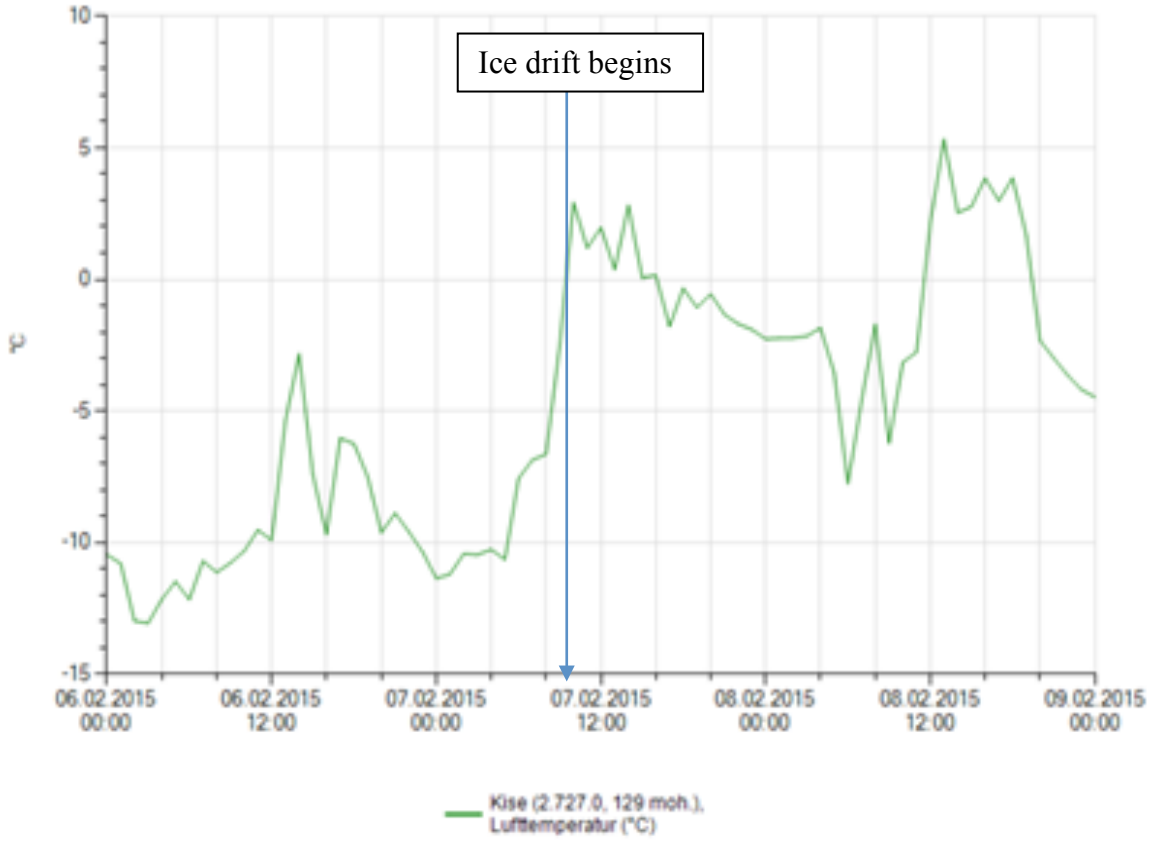
The commissioner will ask the presidents of the involved club to report progress of measures latest at 2016-11-15.

Appendix

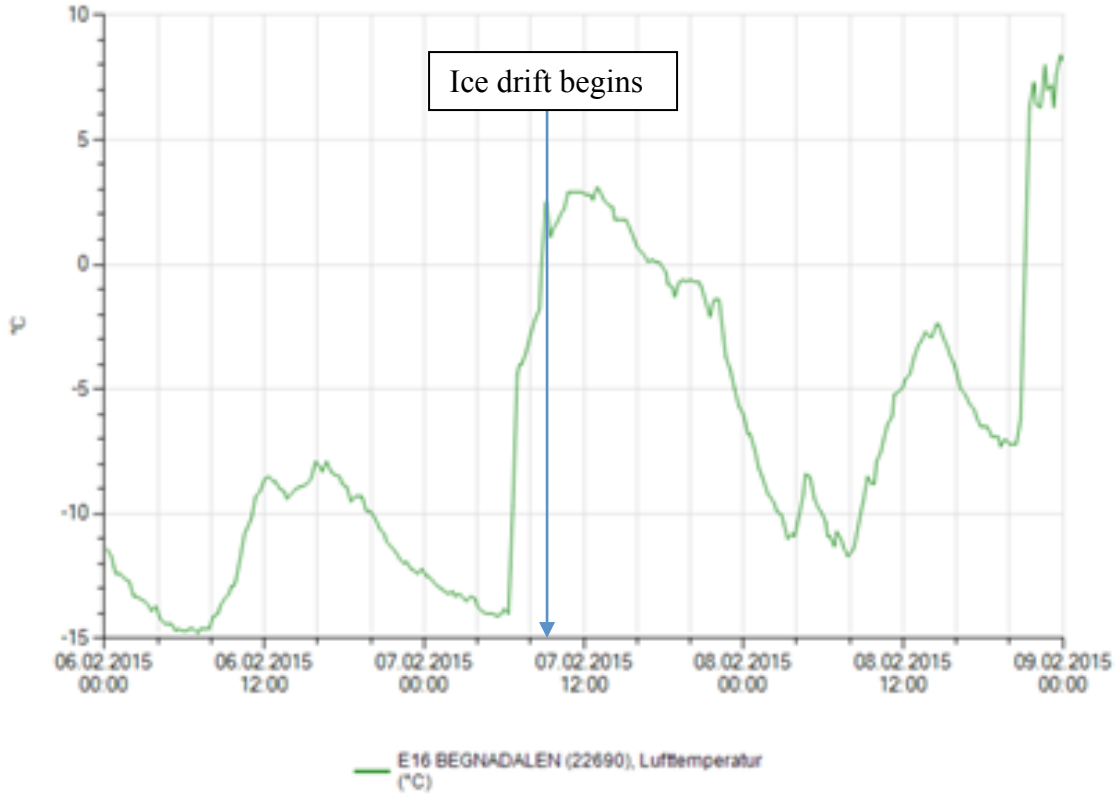
Appendix 1: Weather situation

Temperature

Temperature measurements are from nearby weather stations. (source: www.senorge.no) See also below under wind section where temperature is measured at the E6 bridge north of Gjøvik.



The temperature history for Kise south-east of Gjøvik (red diamond in picture below).



As this picture show, a significant rise in temperature also took place inland south-west of Gjøvik (red diamond in picture below).

It was a cold front passage. The skaters noted a sudden significant temperature rise from approx. -10 °C to around 0 °C after having skated 3/4 of the distance from the eastern to the western shore at sunrise. A credible explanation of the rise in temperature is that during the night and early morning a mass of cold air was present in the valley over the ice. The cold air was trapped there by an inversion. The air mass at higher altitude was much warmer, approx. 0 °C degree. The air temperature behind a cold front is a few degrees lower than ahead of the front.

When a front passes, warm air from higher altitude is mixed up with cold air in the valley. Since the volume of air in the valley is much smaller than the air mass at higher altitudes a temperature increase occurs on the ground.

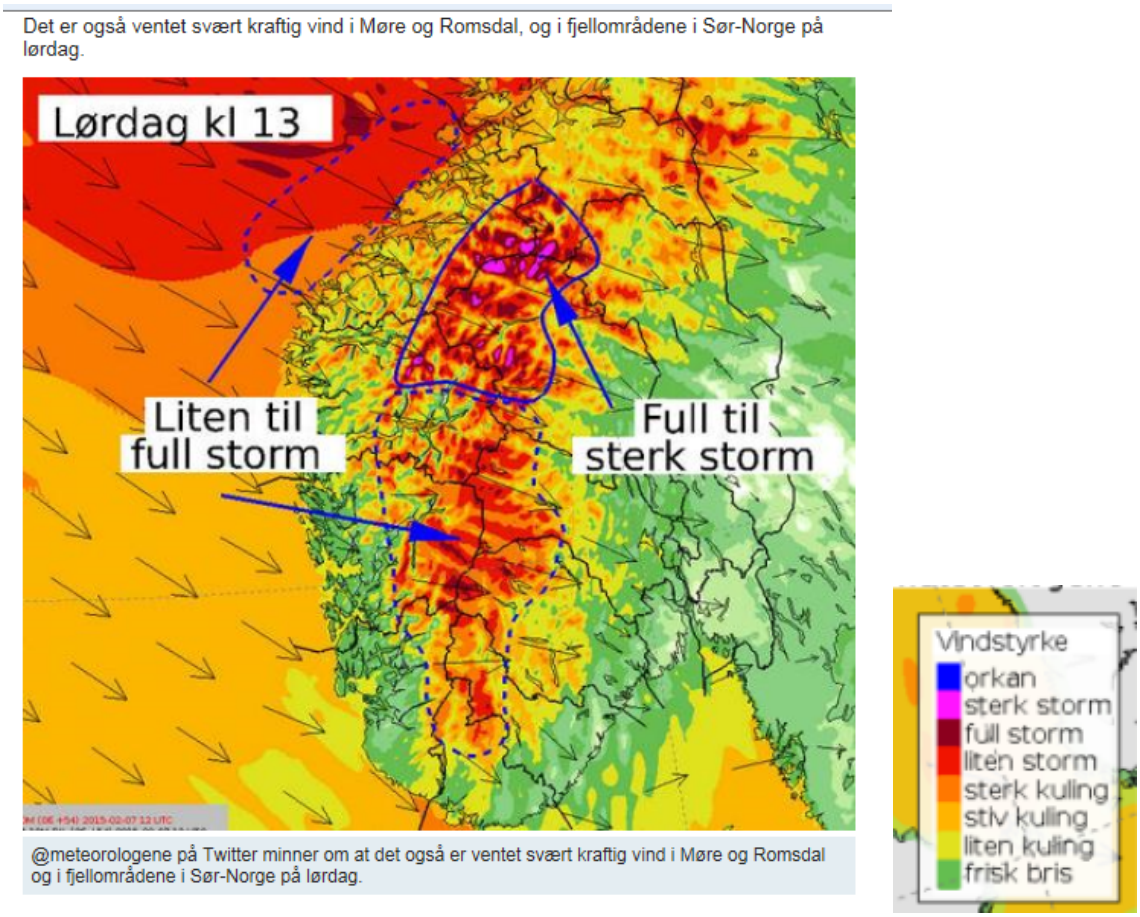
Wind

Forecast

Norway was hit by an extreme storm with high winds occurring in the northern parts of the country. As early as Thursday, February 5, the following warning (including wind map) was given from the Meteorological Institute.

Ekstremværet 'Ole' (hendelse nr.2). 2. varsel - fase B. Siste oppdatering fra meteorologene torsdag 05.02. kl 13:08
Fjellet i Sør-Norge
Høyfjellsområdene i Sør-Norge omfattes ikke av ekstremværplanen; det sendes derfor aldri ekstremværvarsel for disse områdene. Det advares likevel om svært sterk vind i fjellet i Sør-Norge. Det ventes nordvestlig storm 22-30 m/s, med orkan 33 m/s utsatte steder. Værsituasjonen vil bli fulgt opp med obsvarsler.

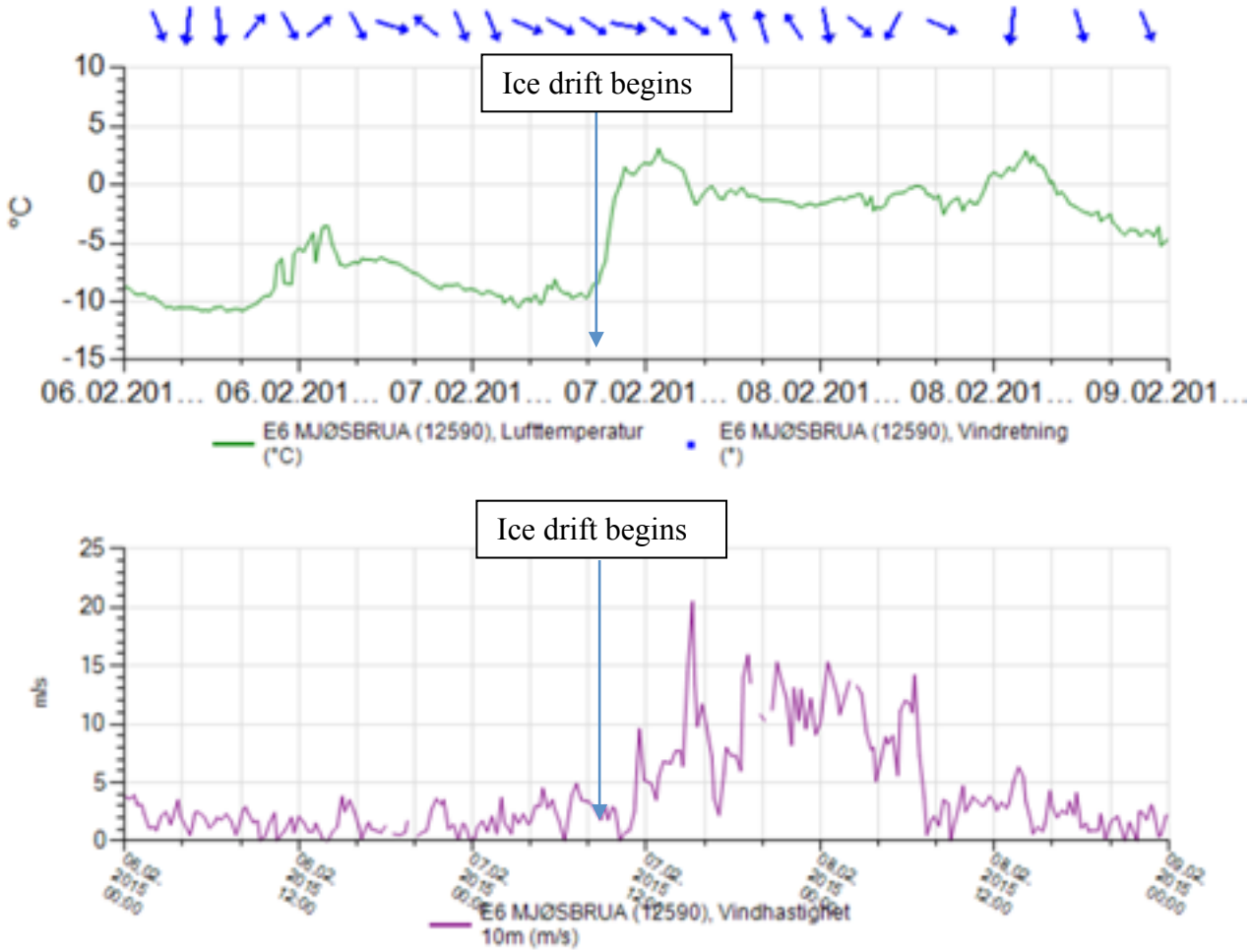
English translation:
Extreme Weather 'Ole' (event No. 2). 2. Alert - phase B. Latest update from meteorologists Thursday 05.02. at 13:08
The southern Norway mountains:
The extreme weather plan does not apply to the high mountain areas of southern Norway; therefore the extreme weather alerts do not go out to those areas. Nevertheless there are warnings of very strong winds in the mountains of southern Norway. A north-westerly storm of 22-30 m/s, with winds of hurricane strength 33 m/s in exposed areas, is expected. New alerts will follow.



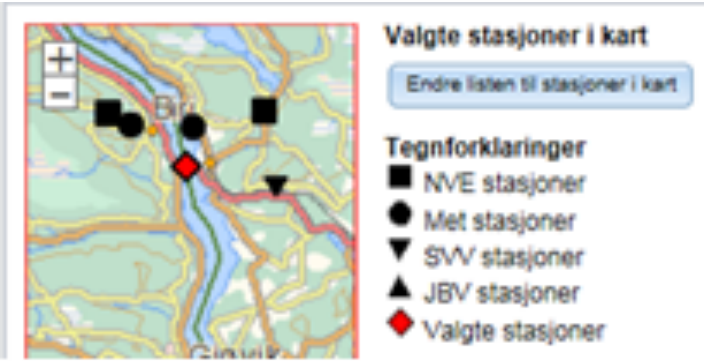
The wind map indicates that Mjøsa is expected to experience a gale Saturday at 13 o'clock.

Measured wind

The site senorge.no has the following wind and temperature history taken from weather stations in the Mjøsa region.

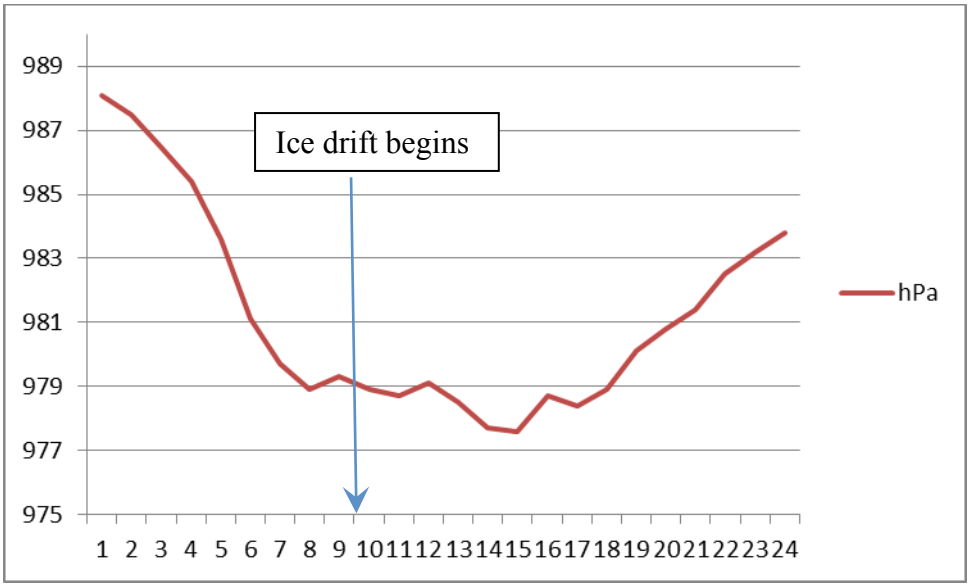


Wind and temperature history from the meteorological station located at the E6 bridge over Mjøsa (red diamond in map below) north of Gjøvik.



Air pressure

Meteorological Institute has supported with an air pressure measurement from Lillehammer. The elevation is the same as in Gjøvik.

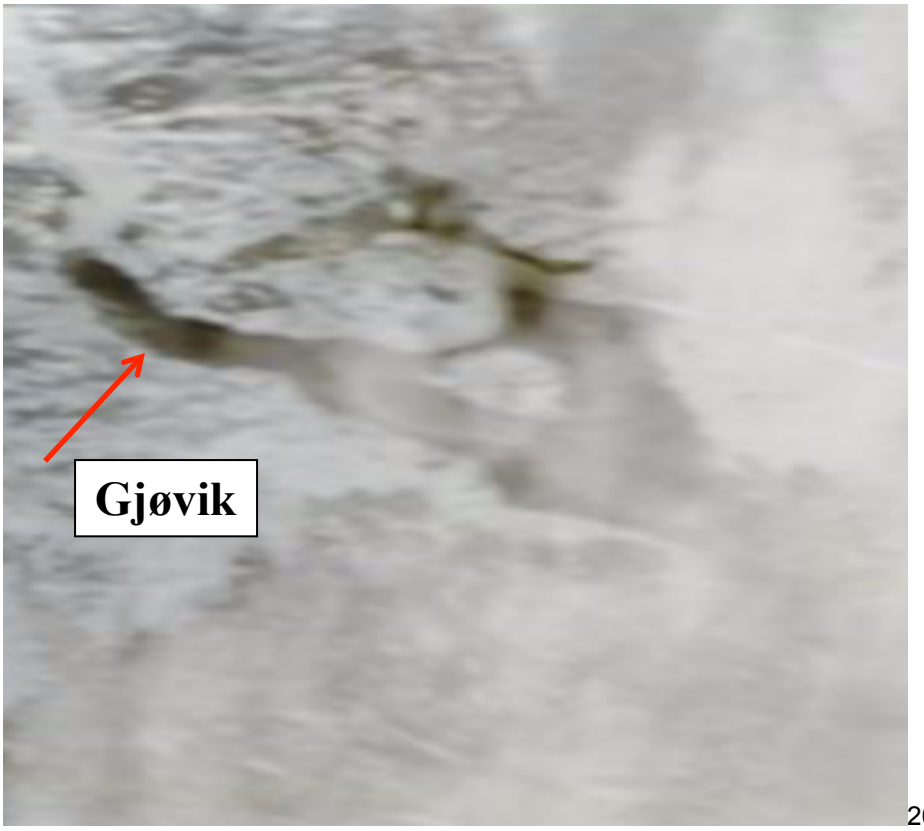


An air pressure drop of about 9 hPa can be observed from midnight to before the ice broke at about 9 a.m.

Ice situation at Mjøsa

NASA satellite pictures the day before and after the incident shows how difficult it can be to analyse images. The dark area outside Gjøvik had ice February 6th and probably open water February 8th.

Source:
https://earthdata.nasa.gov/labs/worldview/?p=geographic&l=MODIS_Aqua_CorrectedReflectance_TrueColor(hidden),MODIS_Terra_CorrectedReflectance_TrueColor,Reference_Labels(hidden),Reference_Features(hidden),Coastlines&t=2015-02-04&v=9.91790771484375,60.23199462890625,11.59771728515625,61.34930419921875

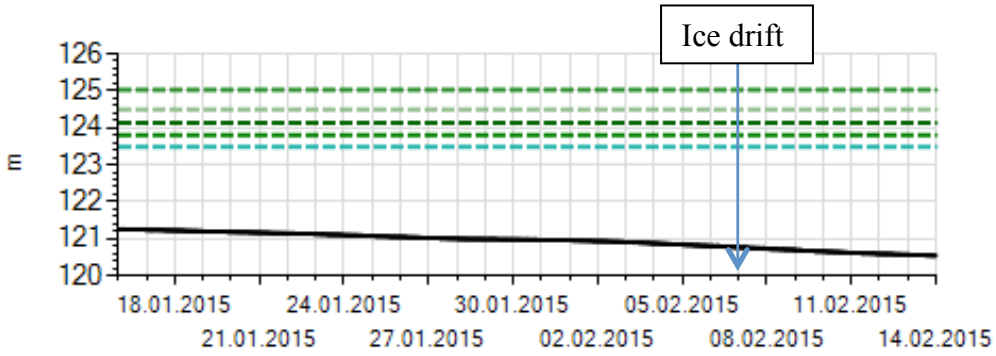


2015-02-06

2015-02-08

Water level and run-off

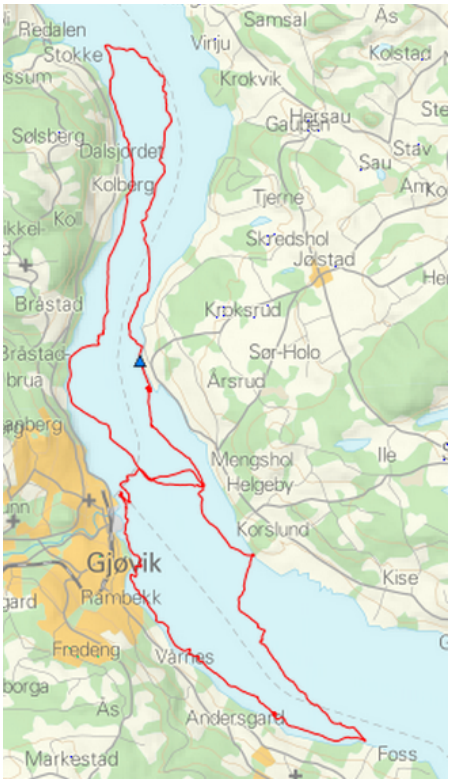
The level is measured at Hamar and shows no significant change, see solid line in diagram below. The level is in the mid of regulation span. (max 122.94 m: min 119.33 m). Obviously the level has been decreased continuously during a long period of time. In the diagram below also some high levels are shown as broken lines. Source:
http://www.senorge.no/index.html?p=senorgeny&st=weather



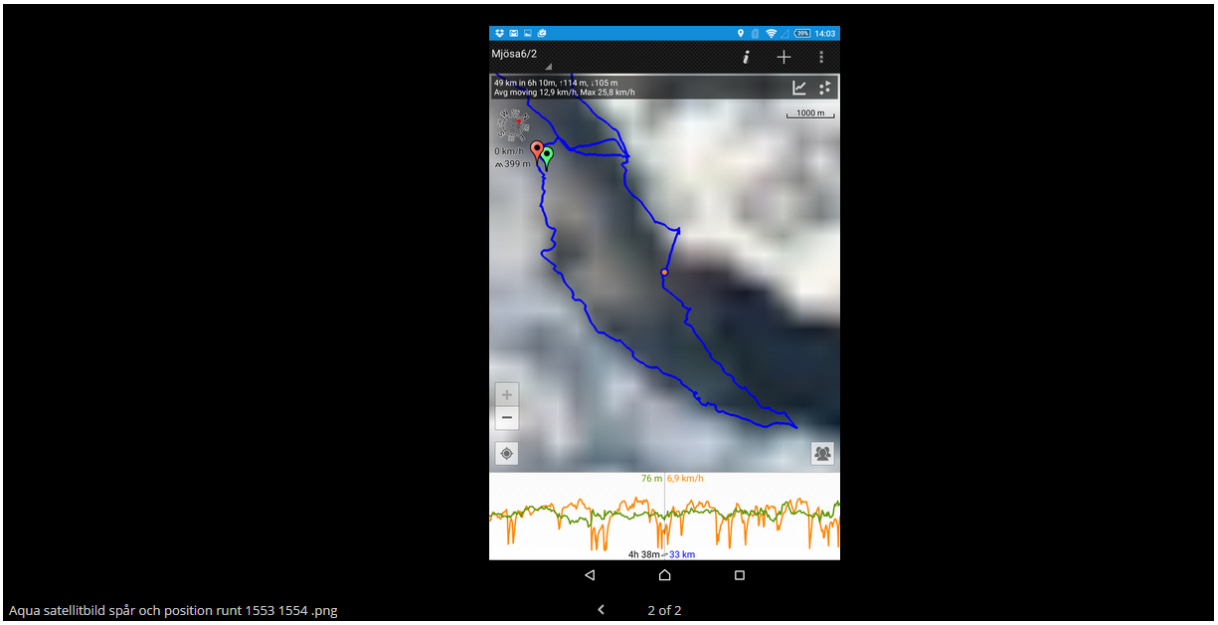
Tours the days before on Mjøsa with importance to this incident

Other skaters made a tour on Mjøsa February 6. Pictures below show ice situation and GPS track.

Crossing from Korslund to Foss is close to open water border. The photo is taken at the crossing.



GPS track from a group of skaters February 6.



The same GPS track laid out on satellite picture

View southward with the shore of Oppland (south of Gjøvik) in the background.

View southward with the shore of Hedmark

View towards northwest with Tangnesodden just behind the skater

Appendix 2: Lake Mjøsa

Norway's largest lake, Mjøsa, can be described as follows:

Hydrologic and morphometric conditions

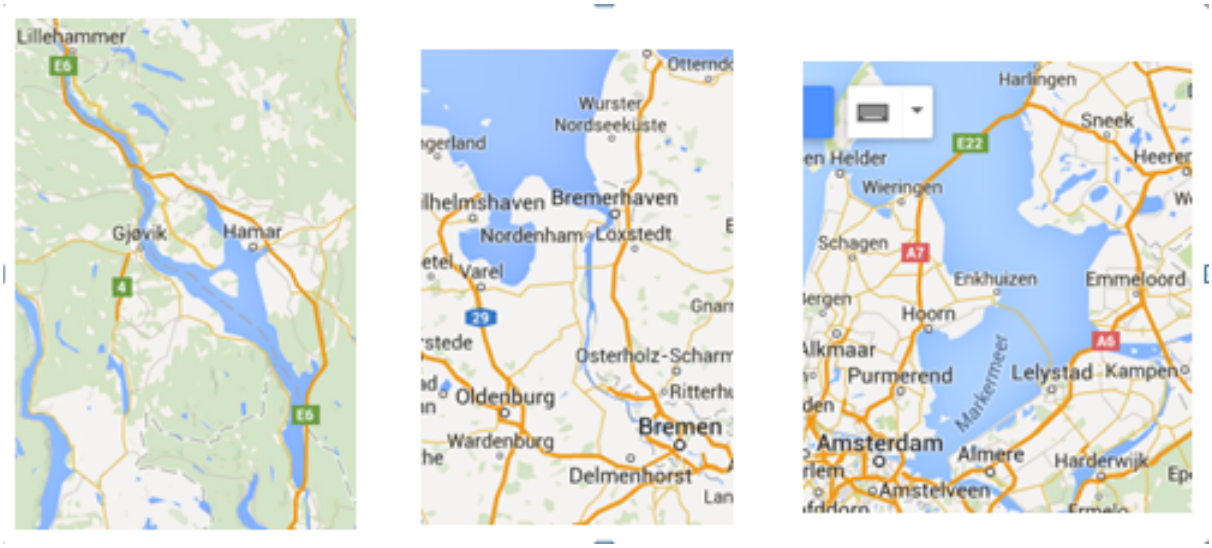
(Sources: (1) NVE Atlas pr.januar 2009; (2) NVE 1984; (3) NVE 2003).

Area catchments	16568 km²	(1)
Lake elevation	123 m	(1)
Lake surface area	369 km²	(1)
Length	117 km	(1)
Biggest measured depth	453 m	(1)
Average depth	150 m	(1)
Volume	55 361 mill. m³	(1)
Mean annual drain	10102 mill. m³	(1)
Theoretical retention	5.48 years	(1)
Highest regulated water level	122.94 m	(1)
Lowest regulated water level	119.33 m	(1)
Regulation height	3.61 m	(1)
Normal summer water	122.80 m	(3)
Highest water level the 1995 flood	125.63 m	(3)

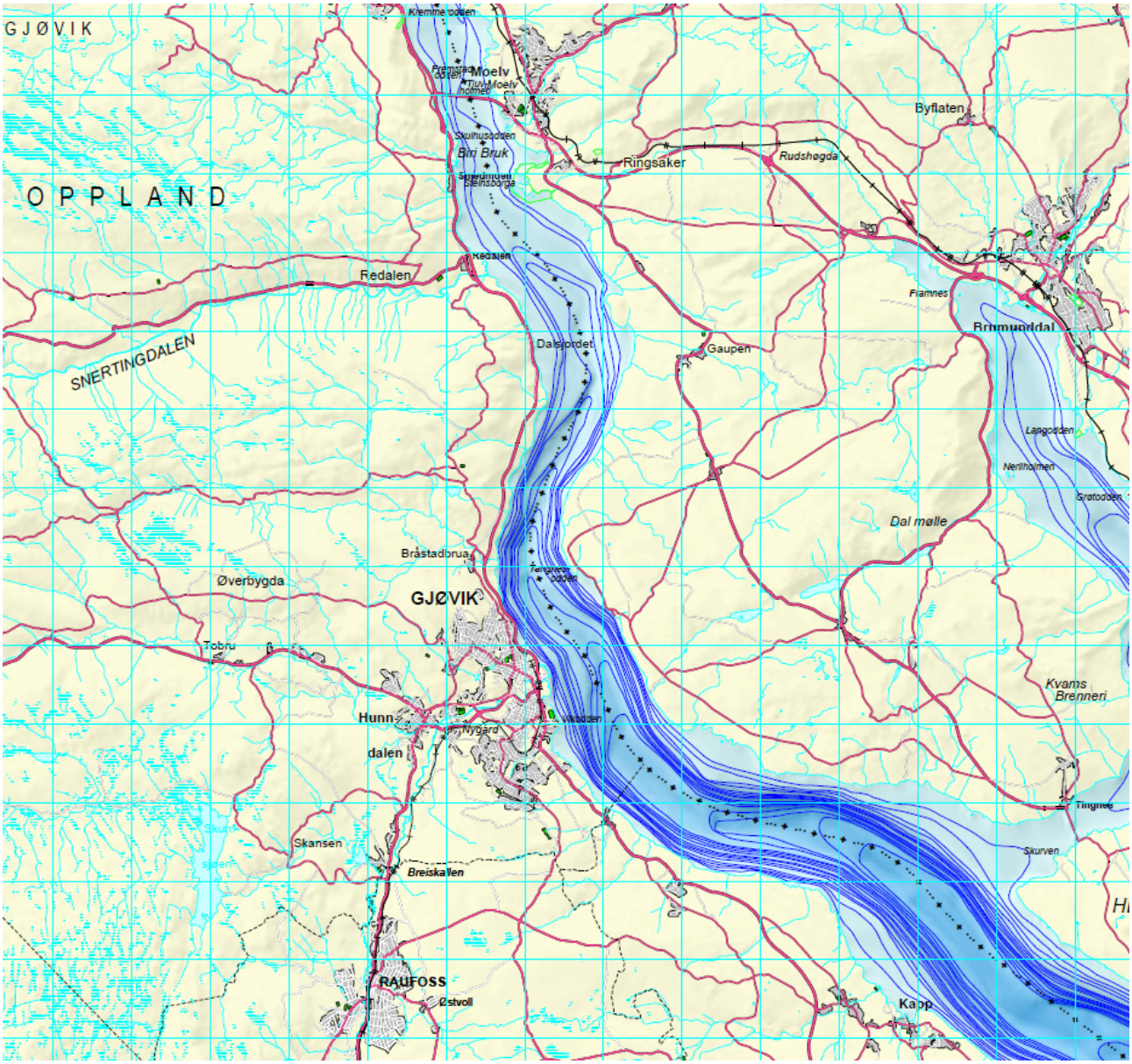
Water flow in the tributaries is usually low in the winter. Meltwater flows usually starts around the transition March-April. Upriver the snowmelting occurs between spring and summer. High water levels can also appear in association with rainfall in summer and autumn. The runoff to Mjøsa is dominated by river Lågen representing 80-90% of the total water supply. Snowmelt and icemelt from mountain areas (including the glaciers in Jotunheimen and Breheimen) characterize the flow pattern in river Lågen. Summer water flow is considerably higher than it would have been without glaciers in the catchment area. In the upper parts of the side river Otta (the tributary most affected by glaciers), melting floods last from May to August/September. Therefore, most of Mjøsas water supply comes from May/June to August (when ice- and snowmelt in the mountainous areas peak). Gudbrandsdalslågen is regulated by two power plants, Harpefossen and Hunderfossen, and there are several power stations in the tributaries Otta, Vinstra, Gausa, Mesna, Hunnselva, Lena and Moelva. Mjøsa is regulated by the power station at Svanfoss in Vorma. Regulation height is 3.61 m.

Seen from above, the silhouetted Mjøsa is like a lake in size between Roxen and Hjälmaren. Unique to Mjøsa is the large depth. Outside Gjøvik the depth drastically increases in the direction of the water flowing southwards.

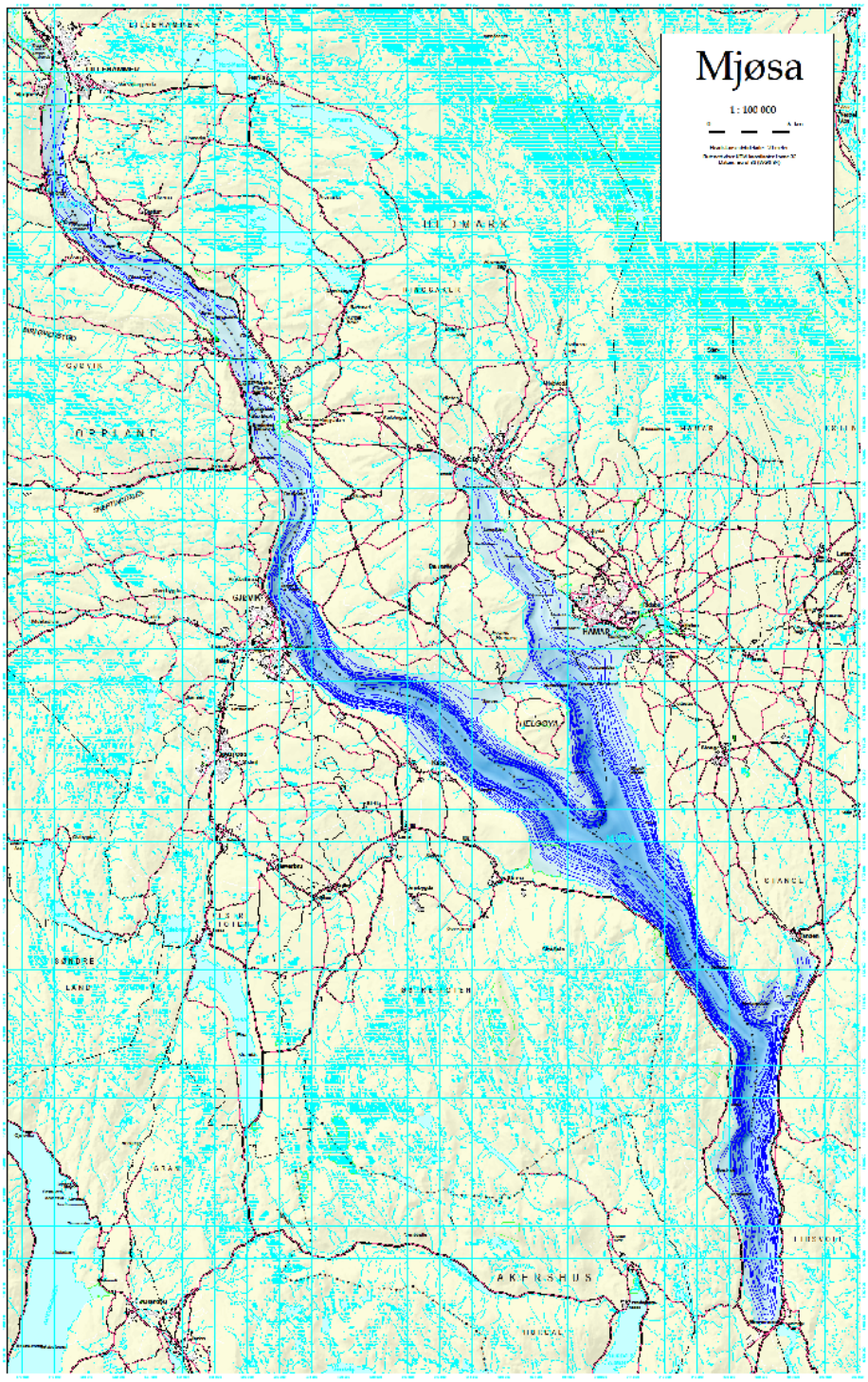
Swedish lakes imaged in the same scale as Mjøsa.



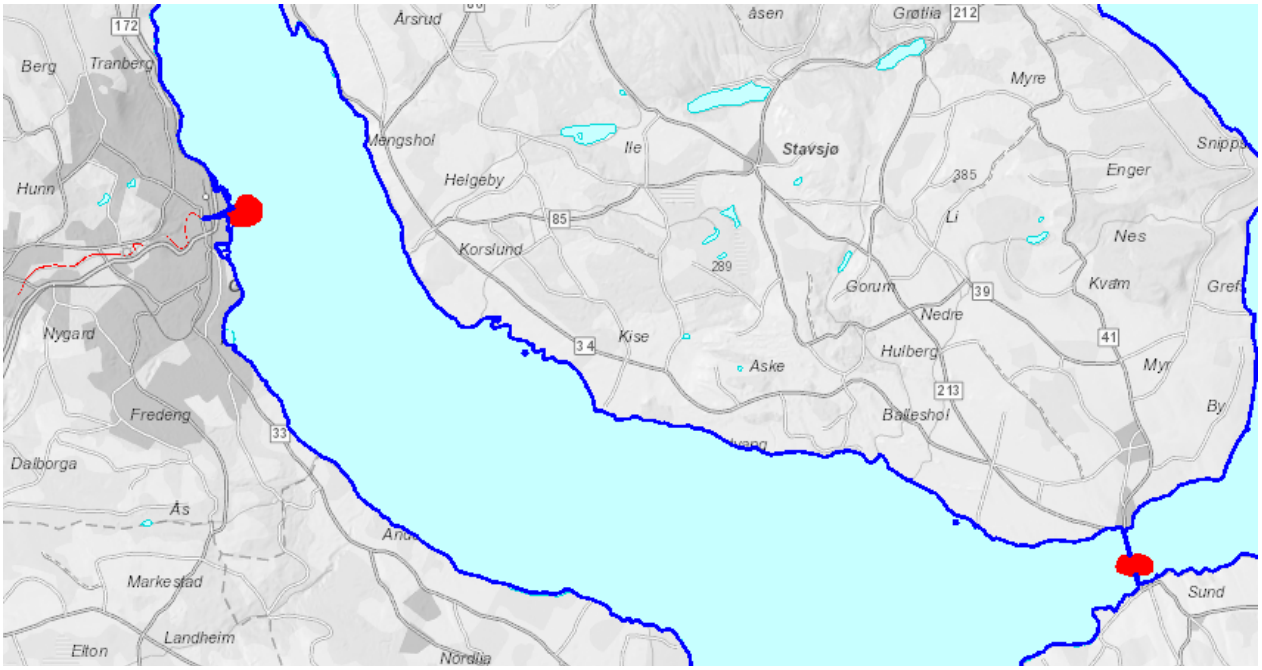
For comparison, maps from Germany and Holland in the same scale as the adjacent Mjøsa map.



Equidistance contours: 20 meters. Source: http://gis3.nve.no/link/?link=innsjodatabase



Equidistance contours: 20 meters. Source: http://gis3.nve.no/link/?link=innsjodatabase



Marked in red: Areas subject to current with risk for unsafe ice. Note that the Hunnselva outlet at Gjøvik harbour is a place with generally unsafe ice. (Source: Norges vassdrags- og energidirektorat)

Source: http://gis3.nve.no/link/?link=innsjodatabase

References

[https://youtu.be/DB9iDt7pjQg] Video with gps tracks and event sequences.

[Askoreport2003] Händelserna vid Askö den 15 februari 2003 Rapport från SSSK:s säkerhetsutredning om händelserna vid Askö den 15 februari 2003, då 36 skridskoåkare som hamnat på isflak räddades av sjöräddningen
http://www.sssk.se/supplier.htm?outfile=/protokoll/utredning/sakerhet/rapporter/2003-11-02-sakerhetsutredn-webbversion.pdf

[Dagsrevyen20150206] Weather forecast on the Norwegian TV program "Dagsrevyen".
http://tv.nrk.no/serie/dagsrevyen/NNFA19020615/06-02-2015#t=25m37s

[SMHIjanfeb2015] www.smhi.se " Januari 2015 - I allmänhet mild och nederbördsrik"
http://www.smhi.se/klimatdata/manadens-vader-och-vatten/2.1118/januari-2015-i-allmanhet-mild-och-nederbordsrik-1.83509. " Februari 2015 - Milda vindar gav tidig vår"
http://www.smhi.se/klimatdata/manadens-vader-och-vatten/2.1118/februari-2015-milda-vindar-gav-tidig-var-1.84784

[SN5feb] www.skridsko.net Tour report 2015-02-05 "Muddy skating on the West Coast"
http://www.skridsko.net/skridskonet/fardrapport/fardrapport-v.asp?ID=50469

.[SN6febMjösa] www.skridsko.net Tour report 2015-02-06 from Mjøsa
http://www.skridsko.net/skridskonet/fardrapport/fardrapport-v.asp?ID=50498

[SN6febÖyeren] www.skridsko.net Tour reports 2015-02-06 from Øyeren
Grupp II: http://www.skridsko.net/skridskonet/fardrapport/fardrapport-v.asp?ID=50490
Grupp III: http://www.skridsko.net/skridskonet/fardrapport/fardrapport-v.asp?ID=50496
Grupp III: http://www.skridsko.net/skridskonet/fardrapport/fardrapport-v.asp?ID=50501
Grupp IV: http://www.skridsko.net/skridskonet/fardrapport/fardrapport-v.asp?ID=50514

[Questionnaire] Answers to the questionnaire sent to all participants (including planning committee and leaders) immediately after the trip.