

Scientizing performance in endurance sports: The emergence of ‘rational training’ in cross-country skiing, 1930-1980.

By Daniel Svensson, Division of History of Science, Technology and Environment, KTH Royal Institute of Technology

daniel.svensson@abe.kth.se

Main supervisor: Sverker Sörlin, Division of History of Science, Technology and Environment, KTH Royal Institute of Technology

Supervisors: Nina Wormbs, Division of History of Science, Technology and Environment, KTH Royal Institute of Technology, and Leif Yttergren, Swedish School of Sport and Health Sciences

Cover picture: Blood test conducted on skier Lars-Göran Åslund during a training session, 27 Sept 1969. Photo: Hallings foto/Jamtli's fotosamlingar.

Table of contents

Foreword

Introduction

The scientization of training in cross-country skiing: Bodies, landscapes, and modernization

- Aim and research questions
- Overview of the research field
- Demarcations
- How the study was conducted – methods and other considerations
- Key concepts
- Theories
- Sportification, rationalization and the development of rational training
- Gender in rational and natural training
- Introducing the articles
- Concluding remarks

Articles

1. Svensson, D. (2013). “How Much Sport is there in Sport Physiology? Practice and Ideas in the Stockholm School of Physiology at GCI, 1941–1969”. *The International Journal of the History of Sport*, 30:8, pp. 892-913.
2. Svensson, D. (2014). “Changing tracks? The battle between natural and scientific training in Swedish cross-country skiing, 1948-1972”. *Sport, history and society*, vol. 33, pp. 12-41.
3. Svensson, D. (2016). “Technologies of sportification – Practice, Theory and Co-Production of Training Knowledge in Cross-Country Skiing Since the 1950s”. *European Studies in Sports History*, 2016 (accepted for publication).
- 4a. Svensson, D. and Sörlin, S. (2015). “Science, Sport et Environnement : le développement des techniques d’entraînement en altitude depuis 1945”, in Quin, Grégory and Bohuon, Anaïs (eds.), *Les Liaisons Dangereuses de la Médecine et du Sport*. Paris: Éditions Glyphe, pp. 195-214.
- 4b. “Science, sport and environment: the development of high-altitude training methods after 1945”. English translation of 4a, not published.

5. Svensson, D. (2014). "I fäderns spår? Längdskidåkningens landskap som kulturarv" [In the tracks of the ancestors: The landscape of cross-country skiing as cultural heritage; in Swedish]. *RIG - kulturhistorisk tidskrift*, vol. 96, nr. 4, pp. 193-212.

Sammanfattning

Dagens elitidrottare använder specialiserade, vetenskapliga träningsmetoder och vetenskapens växande roll inom idrotten är uppenbar. Vetenskapliga metoder och utrustning har även letat sig in i vanliga motionärers träningspraktik, exempelvis i form av pulsklockor och fysiologiska tester. Utvecklingen från erfarenhetsbaserade, personliga träningsmetoder under 1900-talets första hälft till de vetenskapliga träningsmetoderna på 1970-talet, visar på ett skifte i synen på träning och på den idrottande kroppen. Detta skifte är kärnan i föreliggande avhandling.

Rationaliseringsprocessen startade inom konditionsidrotterna, däribland längdskidåkning, under 1940-talet. Den var en del av en kamp mellan två olika träningsideologier; en erfarenhetsbaserad och ”naturlig” och en vetenskaplig och ”rationell”. Den naturliga träningens förespråkare, däribland legendariske träningsideologen Gösta Olander från Vålådalen, såg träningen som en holistisk verksamhet där såväl kropp som själ skulle engageras och menade att träningen bäst bedrevs i natursköna omgivningar till fjälls eller i skogen. Förespråkare av s.k. rationell träning å andra sidan argumenterade för att träningen skulle bygga på fysiologisk forskning, snarare än på tradition. De ville rationalisera inte bara träningen utan även dess landskap, genom standardiserade elljusspår och testlabb.

Rationaliseringen av träning och träningslandskap analyseras här genom sportifieringsteorin. Enligt denna utvecklas de flesta idrotter enligt gemensamma mönster mot ökad rationalisering, reglementering och specialisering. Den här avhandlingen nyanserar sportifieringsteorin genom introduktionen av begreppet *sportifieringsteknologier*, för att förklara betydelsen av mikroteknologier och praktiker (såsom träningsdagböcker, träningsläger och vetenskapliga tester) i rationaliseringen av träning.

Avhandlingen studerar vilken roll vetenskapen har spelat för träningen under 1900-talet. Artiklarna fokuserar på Sverige och längdskidåkning, men jämförelser med andra nationer och idrotter förekommer. Det är en historia om rationalisering av träning, men även om bredare frågor rörande relationen mellan personlig, erfarenhetsbaserad kunskap och vetenskaplig kunskap. De skilda kunskapstraditionerna och deras roller förändrades under 1900-talet och det ökade intresset för kroppen och dess prestationer sammanföll med moderniseringen av Sverige. Genom att studera framväxande vetenskapliga träningsmodeller och deras mer traditionella, erfarenhetsbaserade motparter, kan vår förståelse av modernisering och vetenskapliggörande i samhället i stort nyanseras. De viktigaste slutsatserna är att vetenskapliggörandet aldrig lyckades skala bort de personliga, traditionella och erfarenhetsbaserade elementen från träningen eller träningens landskap, trots att såväl ledande forskningsinstitutioner som idrottsorganisationer stödde den rationella träningsmodellen. En annan slutsats är att försöken att rationalisera träningen var ett led i en bredare rationaliseringsrörelse i Sverige, där kroppens produktivitet skulle förbättras i flera olika sociala och institutionella sammanhang, som skola, militär och näringsliv. I slutändan var träningens teori och praktik en samproduktion mellan praktiker och teoretiker, skidåkare och fysiologer.

Summary

Elite athletes of today use specialized, scientific training methods and the increasing role of science in sports is undeniable. Scientific methods and equipment has even found its way into the practice of everyday exercisers a testament to the impact of sport science. From the experiential, personal training regimes of the first half of the 20th century to the scientific training theories of the 1970s, the ideas about training and the athletic body shifted. That shift is the main focus of this dissertation.

The rationalization process started in endurance sports, among them cross-country skiing, in the 1940s. It was part of a struggle between two models of training; *natural training* and *rational training*. Proponents of natural training, such as the legendary Swedish training ideologist Gösta Olander, saw training as a holistic activity that involved the soul as well as the body and training was best conducted in natural surroundings. Physiologists, on the other hand, wanted to rid training of individual and local variations and create a universal model of rational, scientific training. They even proposed special landscapes suitable for training, such as standardized, flood-lit jogging tracks. The rationalization of training and training landscapes is here understood as an aspect of sportification, a theory commonly used to describe similar developments in sports where increasing regimentation, specialization and rationalization are among the main criteria. This dissertation aims at nuancing the sportification theory by adding the concept of *technologies of sportification* to explain the role that micro-technologies and practices (such as training logs, training camps and scientific tests) have in the scientization of training.

This thesis thus sets out to analyze the role that science has played in training during the 20th century. The articles included focus mainly on Sweden and cross-country skiing, but some international comparisons are also made, as well as comparisons with other endurance sports. This is a history about the rationalization of training, but also about larger issues regarding the role of personal, experiential knowledge and scientific knowledge. The roles of these different knowledge traditions were re-shaped in the modernization of 20th century societies, and the increasing interest in human bodies and performance from scientists coincide with modernization. Through the study of emerging scientific training models, and their more experiential counterparts, our understanding of the modernization and scientization of society as a whole becomes more nuanced. The main conclusions are that the process of scientization, despite being backed by leading organizations and world-leading physiology, never managed to rid training or training landscapes of components from natural, experiential training. Another conclusion is that the effort by Swedish physiologists to introduce *rational training* was part of the larger rationalization movement at the time. In the end, training knowledge was a co-production between practitioners and theoreticians, skiers and scientists.

Keywords

History, environmental history, history of science, history of technology, landscape studies, cross-country skiing, Nordic skiing, endurance physiology, sport history, sportification, sport physiology, sport science, Sweden

Acknowledgements

This work was mainly funded by The Swedish Research Council for Sport Science (CIF). Additional funding was also received from The Swedish National Heritage Board, The Swedish Environmental Protection Agency, and The Swedish Foundation for Strategic Environmental Research (Mistra). A research visit in March 2014 at The Centre for Elite Sports Research in Trondheim, Norway, was made possible by a generous travel grant from Sixten Gemzéus stiftelse/Gålöstiftelsen. The final weeks of work put in to this dissertation were done at the inspiring Jonsered Manor, thanks to a residential scholarship from The Royal Society of Arts and Sciences in Gothenburg.

Introduction

Foreword

The sun seeps through the fir trees and down on the small path. Rocks, roots and dirt are lit up by the sunrays, as my mind is lit up by the song of blackbirds, ravens and cuckoo birds. It's just one of those days, which all who exercise know, when nothing can stop you. I am running on my own, yet not without context. I follow in a tradition that stretches hundreds of years back, a Nordic way of relating to nature, body and mind through personal effort, moving freely across forests and mountains. This is *natural training*. My heart is pounding, I'm exhausted but happy. How happy? That we cannot fully measure, yet.

But how exhausted? How much effect is this having on my fitness level? Have I passed my lactic acid threshold? A brief glance at the pulse watch on my arm confirms the experiential conclusion – I really am exhausted, at 95 percent of max pulse. If I was running timed intervals, the clock would perhaps be more important than the birds and the trees. And suddenly, this is no longer natural training, but rational. Rational in the sense that Swedish physiologists tried to market from the 1940s onwards – scientific training not only for the elite athletes but for everyday exercisers as well. A pulse watch on the arm of the runner, training logs, PTs, hi-tech equipment, self-monitoring. The ambitions of 1940s Swedish physiologists fulfilled. *Rational training* not only for the elite but for the masses as well. A process that started when Eric Hohwü-Christensen was named professor of physiology at The Royal Central Institute of Gymnastics (GCI) in 1941, and is still accelerating.

And ask any skier or runner – when accelerating, the risk of falling increases and the effects become more severe. Doping, questionable gender testing (e.g. the Caster Semenya case), technology that is so effective that it ends up being banned (e.g. the high-tech shark-skin swimwear): the increasing scientization of sport has its benefits and its pitfalls. While running my usual dirt roads and paths through the forest close to home, I have been deeply intrigued by questions about training and its ideology. Hopefully this dissertation can answer some of them. At the very least, it has been a good run.

Some people have run alongside me during all of this. My main supervisor, Sverker Sörlin, Division of History of Science, Technology and Environment at KTH Royal Institute of Technology, has been so much more than a supervisor. Over the last five years, he has tirelessly helped, inspired, guided and challenged me to make the most out of the amazing opportunity that is PhD training. To have such an engaging and brilliant person as a role model in science (and skiing!) has been a true privilege. Thank you!

My assistant supervisors, Nina Wormbs, Division of History of Science, Technology and Environment at KTH Royal Institute of Technology, and Leif Yttergren, Swedish School of Sport and Health Sciences, have both made major contributions both to this research and to my personal development during the almost five years I have spent at KTH. They have been the voice of reason, proposed bold ideas and asked critical questions at times, encouraged me when needed and always made me feel like I could actually make it to the finish line. Thank you!

I would like to express my gratitude to Arne Kaijser, for being like an extra supervisor for the last five years, and to Inga-Maria Mulk, for showing me Sápmi. Thank you also to all my other colleagues at the Division of History of Science, Technology and Environment at KTH, as well as everyone I have

had the opportunity to meet and discuss with in different research projects, at workshops and conferences.

All skiers, physiologists and others who took the time to let me interview them, who taught me a lot about training, skiing, physiology and much more – I am grateful for your time.¹

The input from the opponents at my mid-seminar and final seminar helped improve this dissertation in more ways than I could list here. Thank you Dick Kasperowski, Department of Philosophy, Linguistics and Theory of Science at the University of Gothenburg and Jonny Hjelm, Department of Historical, Philosophical and Religious Studies at Umeå University.

All of my friends and family: thank you for all the support during these years, and all other years. Without you this would never have been possible. This is especially true for my parents, who have encouraged me since day one. You cannot choose your parents, but if I could I would have chosen you every day of the week.

Finally, to my wife Sara and daughter Agnes – you are the light of my life and the reason why this was worth doing. Thank you both!

Daniel Svensson

3 November 2016

¹ These skiers, coaches and scientists are listed with name and time of interview in the respective articles for which they were interviewed.

The scientization of training in cross-country skiing: Bodies, landscapes, and modernization

Aim and research questions

The aim of this research has been to understand the role that science has played in training during the 20th century, and why it has played such a role. This could have been studied in several arenas and places, but I chose cross-country skiing. Such a choice calls for a motivation. Cross-country skiing is a sport with tradition, not least in the Nordic countries. It comes out of a rural tradition of movement and was developed into a sport in Nordic countries, and not (like football and many other sports) imported from the British. It was not first a sport or a game, but a means of transport and personal mobility in northern landscapes that was then sportified. Science played no role at all in skiing in the early 20th century, while today cross-country skiing is intimately related to state of the art sport science. It is a sport that encompasses tensions between rural and urban, between landscapes and labs, between rationalism and romanticism, between innovation and tradition. It is, in many ways, the ideal sport if one wants to understand the scientization of athletes during the 20th century. There has been a shift from what I will refer to as *natural training* — based on a traditional, holistic view of the body and mind of the athlete, and its relation to nature — to the *rational training* based on scientific knowledge, proposed by Swedish physiologists from the 1940s onwards.

Cross-country skiing has a long history in the Nordic countries. As a means of transportation it dates back at least 5200 years, which is the age of the oldest ski found, the Kalvträsk ski.² Skis were widely used for transportation and hunting in most parts of northern Scandinavia and not least in the Sami areas. The first sign of the sportification of skiing can be seen in the late 19th century through ski races such as the 1884 Nordenskiöldsløppet, which the Sami skier Paava Lars Nilsson Tuorda won after having completed the 220 km race in 21 hours and 22 minutes.³ Other competitions, such as Vasaløppet and Birkebeinerrennet, followed in the 1920s and the 1930s.

The organization of skiing as a sport accelerated in the first decades of the 20th century, through the formation of national ski associations in Sweden (1908) and Norway (1908) and the International Ski Federation (1924). There has been a mythological understanding of skiing as something essentially Nordic, tied to culture, landscape, nationality and military efforts.⁴ In Sweden, skiing has had a historical stronghold in the northern parts of the country, where it was an important feature in forestry. This rural, traditional and mythological understanding of skiing faced new ideas in the 1940s, when physiologists started to take interest in the sport and especially in its training methods. The scientific interest in skiing led to a meeting between the rural and traditional understanding of skiing, and the urban and scientific understanding.

This leads to my research questions. How and why did science gain such influence on training? What ideas characterized *rational training* compared to the traditional, natural-experiential training model?

² Västerbottens Museum, official website, "The Ski Exhibition". Retrieved 2016-09-05 at: <<http://www.vbm.se/en/se-and-gora/utställningar/skidutställningen.html>>.

³ Backman, Olle (2011). *Nordenskiöldsløppet 1884: historien om världens hårdaste skidtävling*. Helsingfors: Nordenskiöldsamfundet i Finland.

⁴ Sörlin, Sverker (2010). *Kroppens geni: Marit, Petter och skidåkning som lidelse*. Stockholm: Weyler. Sörlin, Sverker (1995). "Nature, Skiing and Swedish Nationalism", in *The International Journal of the History of Sport*, 1995, vol. 12 (2), pp. 147-163. Kayser Nielsen, Niels (1997). "Movement, Landscape and Sport. Comparative Aspects of Nordic Nationalism between the Wars", in *Ethnologia Scandinavica*, vol. 27, pp. 84-98.

And how has the battle between rational and natural training affected landscapes of training and how they are perceived? This thesis sets out to answer these and other questions about the role that science has played in training during the 20th century. The articles included focus mainly on Sweden and cross-country skiing, but some international comparisons are also made, as well as comparisons with other endurance sports.

This is a history about the rationalization of training, but also about larger issues regarding the role of personal, experiential knowledge and scientific knowledge. The role of these different knowledge traditions was re-shaped in the modernization of 20th century societies, and the increasing interest in human bodies and performance from scientists coincide with modernization. Through the study of emerging scientific training models, and their more experiential counterparts, our understanding of the modernization and scientization of society as a whole becomes more nuanced.

I will use this introductory chapter to position my research as part of the emerging research field in the intersection between sport history, the history of science, and environmental and landscape history. The multitude of methods and theories on which this research builds will be discussed. I will also present some of the key concepts and discussions that are important throughout all the articles. After that, I will present the five articles that are part of this thesis, their main findings, and how they relate to each other. Finally, the key findings and their implications are highlighted in a concluding discussion.

Overview of the research field

A full overview of historical research relating to sport, training, science and landscape is hard to do, because it is too diverse to present in anything less than a full-scale bibliography. Nevertheless, I will try to give some examples from the different research fields and sketch the area where all of the fields above intersect; for it is there I wish to contribute with this thesis. This also serves the purpose of demarcating my area of research.

The history of sports and how they develop has been studied since at least the 1970s. Allen Guttmann's *From Ritual to Record* (1978) is one of the key contributions, and a first attempt to outline a theory of sportification.⁵

Sport historians such as Matti Goksøyr, Gertrud Pfister, Leif Yttergren and others have developed the sportification/sportization theory further, by adding and nuancing criteria.⁶ The theory argues that sports tend to develop along similar patterns, towards increasing organization, regimentation,

⁵ Guttmann, Allen (1978). *From Ritual to Record. The Nature of Modern Sports*. New York: Columbia Univ. Press.

⁶ Yttergren, Leif (1996). *Täflan är lifvet: idrottens organisering och sportifiering i Stockholm 1860-1898*. Stockholm: Stockholmia. Goksøyr, Matti (1988). *Sivilisering, modernisering, sportifiering: fruktbare begreper i idrettshistorisk forskning?*. Oslo. Goksøyr, Matti (1996). "‘Sportsmanship’ in a bourgeois town: Disciplining and character-building or posing and production of status? The role of the emerging sport in the city of Bergen in the last decades of the 19th century", in *Scandinavian Journal of History*, 21:2, pp. 135-149. Collinet, Cécile, Delalandre, Matthieu, Schut, Pierre-Olaf & Lessard, Coralie (2013). "Physical Practices and Sportification: Between Institutionalisation and Standardisation. The Example of Three Activities in France", in *The International Journal of the History of Sport*, 30:9, pp. 989-1007. Pfister, Gertrud (2003). "Cultural confrontations: German Turnen, Swedish gymnastics and English sport – European diversity in physical activities from a historical perspective", in *Culture, Sport, Society*, vol. 6, Issue 1, pp. 61-91. McIntosh, Peter (ed.) (2007). *Landmarks in the history of physical education*. London: Routledge & Kegan Paul.

specialization and rationalization. It has been used to analyze regional and national contexts, as well as individual sports.⁷ I will use it in this dissertation as a tool to explain the developments in Swedish cross-country skiing. A longer discussion on the sportification theory can be found in the theory section. Longer overviews of the historical development of sport and physical education are important to put the 20th century development in perspective. Especially the role of physical education (which has been motivated for moral, nationalist, romantic, racist, conservative, revolutionary, progressive, rationalist, religious and other reasons) is interesting to look at, and there have been ambitious efforts in this regard.⁸ There were other areas of scientific knowledge production relating to the human body and its performance – not least in military, industrial and educational contexts – but sport was an important aspect and formed a special branch of this knowledge production. When it comes to the history of training and how it has changed over time, I have found very few examples. The best one relating to endurance sports is the American Nicholas David Bourne’s dissertation *Fast science: a history of training theory and methods for elite runners through 1975*.⁹ Even if it deals with running and not cross-country skiing, the developments in training are partly the same while the role of science is not in focus in Bourne’s dissertation. Local, national and regional or continental histories of sport are also common.¹⁰ I have no detailed knowledge of the amateur history scenes in other countries, but at least in Sweden much of the historiography is done in local sport history societies, by amateur historians. Such contributions have been very important, both for mapping the breadth of sport history and as source material for national and international overviews by academic historians. Histories of specific clubs also fall under this category, and there are an abundance of those as many sports clubs tend to publish club histories (of different levels of ambition) for their anniversaries.¹¹

Histories of cross-country skiing are far less common because it is a relatively small sport in a global perspective. Norway is an exception, with quite a large literature on cross-country skiing including

⁷ See previously mentioned Yttergren, *Täflan är lifvet*. Sjöblom, Paul and Fahlén, Josef (2010). “The survival of the fittest: intensification, totalization and homogenization in Swedish competitive sport”, in *Sport in Society: Cultures, Commerce, Media, Politics*, 13:4, pp. 704-717. Horton, Peter (2012). “The Asian Impact on the Sportisation Process”, in *The International Journal of the History of Sport*, 29:4, pp. 511-534. For studies of certain individual sports, see e.g.: Bromber, Katrin, Krawietz, Birgit and Petrov, Petar (2014). “Wrestling in Multifarious Modernity”, in *The International Journal of the History of Sport*, 31:4, pp. 391-404. Groenen, Haimo (2014). “La préparation des premières Olympiades de judo en France entre 1960 et 1964: un facteur de sportivisation de l’entraînement et de la discipline japonaise”, in *European Studies in Sports History*, No 7: 2014.

⁸ Mechikoff, Robert A. and Estes, Steven (2009). *A history and philosophy of sport and physical education: from ancient civilizations to the modern world*. 5. ed. Boston, MA: McGraw-Hill.

⁹ Bourne, Nicholas D. (2008). *Fast science: a history of training theory and methods for elite runners through 1975*. Ann Arbor, MI: ProQuest.

¹⁰ E.g. Rouse, Paul (2015). *Sport and Ireland: a history*. First edition. Holt, Richard (1989). *Sport and the British: a modern history*. Oxford: Clarendon. Morrow, Don and Wamsley, Kevin B. (2005). *Sport in Canada: a history*. Don Mills, Ont.: Oxford University Press. Roger, Anne, and Terret, Thierry (2011). *European Athletics: A Continental History of Track and Field (1912–2010)*. Stuttgart: Neuer Sportverlag. Schiller, Kay and Young, Christopher (2009). “The History and Historiography of Sport in Germany: Social, Cultural and Political Perspectives”, in *German History*, 27:3, pp. 313-330. Morris, Andrew D. (2004). *Marrow of the nation: a history of sport and physical culture in Republican China*. Berkeley, CA: University of California Press. Grant, Susan (2013). *Physical culture and sport in Soviet society: propaganda, acculturation, and transformation in the 1920s and 1930s*. New York: Routledge.

¹¹ E.g.: Kväre, Stellan (2009). *IFK Mora: de första 100 åren*. Mora: Dala media. Borgås, Göran (1988). *IFK Ulricehamn 50 år: 50 år med IFK*. Ulricehamn: IFK Ulricehamn. Andersson, Roger (2007). *IK Ymer jubileumsbok. D. 1, Några ögonblick ur 90 år*. Borås: Idrottsklubben Ymer. Forsman, Bengt (ed.) (2001). *100 år av idrottshistoria: IFK Umeå 100 år, 1901-2001*. Umeå: Idrottsfören. Kamraterna. IK Stern (1984). *Idrottsklubben Stern: 50 år med Idrottsklubben Stern 1934-1984*. Göteborg: IK Stern. OK Landehof (2006). *OK Landehof: 1955-2005: 50 år*. Landvetter: Orienteringsklubben Landehof.

general histories, biographies and training instructions.¹² One name, Thor Gotaas, stands out in the Norwegian literature. He has written several books of importance for this dissertation.¹³ Sverker Sörlin's *Kroppens geni*, where he examines the culture of skiing in Norwegian Trondelag, is another example.¹⁴ The American journal *Skiing History* (formerly known as *Skiing Heritage*) deals with all forms of skiing, including cross-country/Nordic skiing.¹⁵ There are also a few attempts to discuss skiing in relation to national identity, and it seems that the sport, due to its close relation to landscape (another category of importance for nationalist discourses), is particularly potent in this regard.¹⁶ Despite the relative scarcity of academic cross-country skiing histories, there are many biographies of individual sport leaders and athletes involved in the sport. I have used some of these as sources in my research, and there is a rich flora of others that I will not list here.

Medicine and physiology have for a long time generated research about endurance and performance, not only in sport but in different areas of society such as work, military and education. This vast field of research is now historicized, linking to history of science, medicine, industry, military, organization and, eventually, sports. If we look at the scientific aspects of sports, the history of sports medicine, sports physiology and other scientific efforts relating to sports and training have been studied, not least in the United States and Great Britain (but there are also examples regarding the Soviet Union, Germany, France and a range of other countries). These studies show that there has been a growing scientific interest in sports during the 20th century, and that scientists have had a massive impact on the training theory of many sports. It is also clear that scientists had larger ambitions than just contributing to sports – the testing of athletes was part of a wider examination of the human body at work.¹⁷ The

¹² E.g. Sandbakk, Øyvind and Tønnesen, Espen (eds.) (2012). *Den norske langrennsboka*. Oslo: Aschehoug. Vaage, Jakob (1977). *Skismøringens historie*. Skårer: Swix Sport International. Alnæs, Karsten (2007). *Jeg spenner mine ski: historien om norsk skikultur*. Oslo: Aschehoug. Alsgaard, Thomas and Karlsen, Marit (2008). *Best på ski: Trening, teknikk, kosthold, konkurranse*. Oslo: Tun. Wigernaes, Ingrid (1967). *Mot mål med jentutn*. Oslo: Aschehoug.

¹³ Gotaas, Thor (2010). *Først i løypa: historien om langrenn i Norge*. Oslo: Dreyer. Gotaas, Thor (2007). *Skimakerne: historien om norske ski*. Oslo: Gyldendal. Gotaas, Thor (2011). *Norway – the Cradle of Skiing*. Nesøya: Font Forlag.

¹⁴ Sörlin, *Kroppens geni: Marit, Petter och skidåkning som lidelse*.

¹⁵ The International Skiing History Association (ISHA), official website. "Skiing History Magazine". <<https://www.skiinghistory.org/skiing-history-magazine>>. Retrieved 2016-07-14.

¹⁶ Engel, Peter (2013). "The Discursive Construction of National Identity through the Swiss Magazine SKI Before World War I" in *The International Journal of the History of Sport*, 30:6, pp. 598-616. Sörlin, Sverker (1995). "Nature, Skiing and Swedish Nationalism", in *The International Journal of the History of Sport*, 1995, vol. 12 (2), pp. 147-163. Batagelj, Borut (2013). "Slovenian Skiing Identity: Historical Path and Reflection" in *The International Journal of the History of Sport*, 30:6, pp. 647-658.

¹⁷ E.g. Johnson, Andi (2009). *Human Performance. An Ethnographic and Historical Account of Exercise Physiology*. Ann Arbor, MI: Proquest. Heggie, Vanessa (2011). *A History of British Sport Medicine*. Manchester: Manchester University Press. Park, Roberta J. (2011). "Physicians, Scientists, Exercise and Athletics in Britain and America from the 1867 Boat Race to the Four-Minute Mile", in *Sport in History*, 31:1, pp. 1–31. Hoberman, John M. (1992). *Mortal Engines: The Science of Performance and the Dehumanization of Sport*. New York: Free Press. Krüger, Arnd (1997). "The History of Middle and Long Distance Running in the Nineteenth and Twentieth Century", in *La Comune Eredità dello Sport in Europa: Atti del I Seminario Europeo di Storia dello Sport*, edited by Arnd Krüger and Angela Teja, pp. 117–124. Rome: CONI. Rabinbach, Anson (1990). *The Human Motor. Energy, Fatigue, and the Origins of Modernity*. New York: Basic Books. Wrynn, Alison M. (2010). "The Athlete in the Making: The Scientific Study of American Athletic Performance, 1920–1932", in *Sport in History*, 30:1, pp. 121–137. Howe, P. David (2006). "Habit, Barriers and the [Ab]use of the Science of Interval Training in the 1950s", in *Sport in History*, vol. 26, no. 2, pp. 325-344. Carter, Neil (2010). "The Rise and Fall of the Magic Sponge: Medicine and the Transformation of the Football Trainer", in *Social History of Medicine*, vol. 23, no. 2, pp. 261–279. Tipton, Charles M. (2014). "Chapter 1. Antiquity to the Early Years of the 20th Century", in Charles M. Tipton, *History of Exercise Physiology*. Champaign IL, Human Kinetics, p. 3-32. Bassett, David R. (2002). "Scientific contributions of A.V. Hill: exercise physiology pioneer", in *Journal of Applied Physiology*, 93, pp. 1567-1582. Park Roberta J. (2014). "Play, Games and Cognitive

increasing role of science in sports underlines the rise of sports as a culturally, politically and economically interesting phenomenon. The impact of science in sports can also be seen from the perspective of certain organizations, like the International Council of Sport Science and Physical Education or the European College of Sport Science.¹⁸

For Sweden, there are quite a few publications, despite the rather short academic history of the subject. Vidar Martinell's three volumes on Swedish ski history is an important contribution of facts and statistics.¹⁹ General overviews have been done from the history of rural, spontaneous play to modern sports.²⁰ Jan Lindroth's dissertation from 1974, *Athletics becomes a popular movement: studies in the Swedish athletics movement up until 1915*, was the first Swedish dissertation with a clear focus on the history of sports. Lindroth emphasized the role of civil society in the formation of Swedish sports, while in this dissertation I will also highlight the efforts of the Swedish state to organize and rationalize the physical activity of the population. In the 1970s, sport history was a new subject without a clear academic home and with no higher positions to support it. However, there were many amateur historians and local sports history societies that took an interest in the subject. With the formation of the Swedish association for sports history (Svenska idrottshistoriska föreningen) in 1976, academic and amateur historians and others that were interested had a social arena where discussions about sports history could be developed.²¹

In 1981, the first issue of the now peer-reviewed yearbook *Idrott, historia och samhälle (Sport, History and Society)* further contributed to the formation of sports history as an academic subject in Sweden. Jan Lindroth was granted a position as professor in sports history at Stockholm University in 1992, an important step forward for the field. The 1990s then saw sports history of quite empirical style, mapping the history of sports in Sweden. A great number of dissertations and articles have contributed to the field, and many have dealt with the development of a certain sport and/or sports in a certain city or region. I am trying to address the development of sports from yet another angle, relating the history of sports to the history of science. I see such combinations as an important development in the history of sports, a field of research that has taken shape only recently and has therefore not seen very many specialized investigations. On the contrary, it is characterized by a kind of multi-disciplinary approach, both regarding different specializations within history (e.g. history of sports, history of ideas, economic history) and other disciplines such as medicine, physiology, ethnology, geography and anthropology. This has resulted in a sports history that is relevant far beyond the confines of sports itself. It has the potential to historicize important features of modern society through the lens of sports. This is also what this study aims to accomplish.

Development: Late Nineteenth-Century and Early Twentieth-Century Physicians, Neurologists, Psychologists and Others Already Knew What Researchers Are Proclaiming Today", in *The International Journal of the History of Sport*, 31.9, pp. 1012-1032. Carter, Neil (2012). *Medicine, Sport and the Body. A Historical Perspective*. London: Bloomsbury.

¹⁸ Bailey, Steve (1996). *Science in the service of physical education and sport: the story of the International Council of Sport Science and Physical Education, 1956-1996*. Chichester: Wiley.

¹⁹ Martinell, Vidar (1999). *Skidsportens historia, Längd 1800-1949*. Järna: Martinell. Martinell, Vidar (2001). *Skidsportens historia, Längd 1950-1979*. Järna: Martinell. Martinell, Vidar (2003). *Skidsportens historia, Längd, 1980-1999*. Järna: Martinell.

²⁰ E.g. Sandblad, Henrik (1985). *Olympia och Valhalla: idéhistoriska aspekter av den moderna idrottsrörelsens framväxt* [English title: Sport and ideas: aspects of the rise of the modern sport movement]. Grillby:

Lärdomshistoriska samfundet. Lindroth, Jan (1974). *Idrottens väg till folkrörelse: studier i svensk idrottsrörelse till 1915* [English title: Athletics becomes a popular movement: studies in the Swedish athletics movement up until 1915]. Uppsala: Uppsala University. Hellspong, Mats (2000). *Den folkliga idrotten: studier i det svenska bondesamhällets idrotter och fysiska lekar under 1700- och 1800-talen*. Stockholm: Nordiska museets förlag.

²¹ Swedish association for sport history, "Om SVIF", <<http://www.svif.net/omsvif.htm>>.

The history of the body (though not primarily the athletic body) has also been studied, as has the role of training for public health in Sweden.²² As for the history of training, however, not much has been done. Leif Yttergren's history of endurance training in Swedish athletics is one of the few academic efforts in this regard, along with studies on the histories of football and cycling, which involve some elements of training.²³ There have been some (but surprisingly few) efforts to map changes in training in certain sports, like orienteering and football.²⁴ The relationship between competitive sports and the state has been studied, though not with focus on training and knowledge.²⁵

Both the role of athletes in scientific studies of the body at work (i.e. work physiology) and the historical role of science in sports have been more or less neglected in Sweden as an area of study, while such studies have made important contributions to our understanding of the relation between science and sports in other countries, especially around the role of the test subject and physiologists performing tests on themselves.²⁶

The same goes for the landscapes of sport, their histories and possible role as cultural heritage. While studies from other contexts (not least the UK) of the geography and heritage of sports have contributed to the understanding of sport and place, sport landscapes have not been a prioritized field in Swedish academia.²⁷ What research there is available suggests that perceptions and ideas about running are clearly represented in the landscapes designed for this purpose. In Sweden, the forest is perceived as a natural place for running, and this is reflected in the specially designed flood-lit tracks for fitness running.²⁸ These tracks were suggested by physiologists as part of their *rational training*, but clearly elements of *natural training* still made it into this infrastructure for training nonetheless.²⁹ There have been attempts by historians, most notably Håkan Karlsson at the University of Gothenburg, to promote sports heritage as an important category for the cultural heritage sector, but so far the practical impacts

²² E.g. Ekenstam, Claes (2006). *Kroppens idéhistoria: disciplinering och karaktärsdaning i Sverige 1700-1950*. Hedemora: Gidlund. Lundquist Wanneberg, Pia (2004). *Kroppens medborgarfostran: kropp, klass och genus i skolans fysiska fostran 1919-1962*. Stockholm: Stockholms universitet. Bolling, Hans (2005). *Sin egen hälsas smed: idéer, initiativ och organisationer inom svensk motionsidrott 1945-1981*. Stockholm: Stockholms universitet.

²³ E.g. Yttergren, Leif (2012). *Träna är livet: träning, utbildning och vetenskap i svensk friidrott, 1888-1995*. Malmö: idrottsforum.org. Sund, Bill (2012). *Backe upp och backe ner: Svensk cykelsport och cykelhistoria i ett internationellt perspektiv*. Malmö: Idrottsforum.org. Peterson, Tomas (1993). *Den svengelska modellen: svensk fotboll i omvandling under efterkrigstiden*. Lund: Arkiv

²⁴ Andersson, Frida, Vångell, Fredrika and Yttergren, Leif (2011). "Orienteringsträning i förändring: En komparativ studie av orienteringsträning på elitnivå på 1980-talet och 2010". Malmö: Idrottsforum.org/Nordic sport science forum. Hoff, Jan and Helgerud, Jan (eds.) (2002). *Football (soccer): new developments in physical training research*. Trondheim: NTNU.

²⁵ Sjöblom, Paul (2006). *Den institutionaliserade tävlingsidrotten: kommuner, idrott och politik i Sverige under 1900-talet*. Stockholm: Stockholms universitet.

²⁶ Johnson, Andi (2015). "'They Sweat for Science': The Harvard Fatigue Laboratory and Self-Experimentation in American Exercise Physiology", in *Journal of the History of Biology*, 48:3, pp. 425-454.

²⁷ E.g.: Bale, John (2003). *Sports geography*. London: Routledge. Bale, John & Sang, Joe (1996). *Kenyan running: movement culture, geography, and global change*. London: Frank Cass. Hill, Jeff, Moore, Kevin & Wood, Jason (eds.) (2012). *Sport, history, and heritage: studies in public representation*. Woodbridge, UK: Boydell Press. Bairner, Alan (2009). "National sports and national landscapes: In defence of primordialism", in *National Identities*, 11:3, pp. 223-239. Wicken, Ingrid P. (2012). *Lost Ski Areas of Southern California*. California: The History Press.

²⁸ Qviström, Mattias (2016). "The nature of running: On embedded landscape ideals in leisure planning", in *Urban Forestry & Urban Greening*, 17:1, pp. 202-210.

²⁹ Qviström, Mattias (2013). "Landscapes with a heartbeat: tracing a portable landscape for jogging in Sweden (1958-1971)", in *Environment and Planning A*, 45, pp. 312-328.

have been limited.³⁰ The Swedish Sports Confederation celebrated its centennial in 2003 by selecting one hundred places of special historical significance, a first attempt to map a heritage of sports.³¹ However, the available information and visualization of these places as heritage remain quite scant. Efforts to date by sport historians to underline the importance of sport places and heritage remain few, despite such an undertaking involving the founder of the field of sport history in Sweden, Jan Lindroth, and one of Norway's leading sport historians, Matti Goksøyr.³²

The lack of interest in the landscapes of skiing and the relations between sport, science and landscape is slightly surprising. After all, skiing in all of its forms is still (despite the rapid development of ski tunnels, artificial snow and other signs of technification and indoorization) dependent on nature and weather conditions. Closely related to the landscape issue are the advances in ski waxing, one of the most specialized and scientized aspects of cross-country skiing. After the FIS World Championships in Falun in 2015, where Petter Northug made an impossible comeback and won in heavy snowfall during the Men's 50 km race, there were many complaints about this being a parody of skiing due to the poor conditions (because heavy snowfall means that those who are first in the tracks will most likely be slowed down more than those who follow, something Northug brilliantly took advantage of in Falun). Others would probably say that indoor skiing is the real parody. No matter where you stand in all of this, weather conditions are a factor of great importance, where the role of science has increased over time.

Perhaps the lack of research and public attention around training history and heritage is because this is not a clearly defined research field, but rather one that relates to a number of scientific disciplines, cultural processes and popular practices. This dissertation can contribute by linking these diverse fields together through the history of cross-country skiing. By doing so, I also help articulate a field of research about the role of athletic bodies and landscapes in science, about meetings between different traditions of knowledge, and about the role of training in a modern welfare state such as Sweden. Scientific influence on everyday practices (be it training, cooking, cleaning, etcetera) has received some interest in Sweden so far, but given the magnitude of scientific influence in many areas there is room for much more.³³ When it comes to work physiology, Sweden has been nearly world leading. Bengt Saltin, Per-Olof Åstrand and Björn Ekblom have had a large impact in this field, yet their work has not attracted much interest from historians (although some interest from physiologists, e.g. Peter Schantz, Per Renström and Jon Karlsson).³⁴ One of the ambitions of this dissertation is to add further

³⁰ Karlsson, Håkan (2008). "Mellan kanon, dialog och fotboll – kulturavets demokratiska potential", in Jönsson, Lars-Eric, Wallete, Anna och Wienberg, Jes (eds.), *Kanon och kulturarv. Historia och samtid i Danmark och Sverige*. Göteborg/Stockholm: Makadam. See also: Karlsson, Håkan (2010). "Fotbollens idrottshistoriska platser. Ett försummat kulturarv", in *Idrott, Historia, Samhälle*, 2010, pp. 84-100.

³¹ For a full list of these 100 places, see The Swedish Sports Confederation website, <<http://www.rf.se>>.

³² Pihl Atmer, Ann Katrin and Lindroth, Jan (eds.) (2001). *Idrottens platser*. Uppsala: Swedish Science Press. Goksøyr, Matti. "Skis as National Symbols, Ski Tracks as Historical Traits: The Case of Norway", in *2002 International Ski History Congress*, edited by E. John B. Allen, pp. 197– 203. New Hartford: International Skiing History Association, 2002.

³³ There are a few exceptions, e.g.: Hagberg, Jan-Erik (1986). *Tekniken i kvinnornas händer: hushållsarbete och hushållsteknik under tjugo- och trettiotalen*. Malmö: Liber. Johannisson, Karin (1991). *Folkhälsa: det svenska projektet från 1900 till 2:a världskriget*. Lychnos. 1991, pp. 139-195. Kaijser, Arne and Sax, Ulrika (2013). *A tribute to the memory of Brita Åkerman (1906-2006), Carin Boalt (1912-1999): presented at the 2013 Annual Meeting of the Royal Swedish Academy of Engineering Sciences*. Stockholm: Royal Swedish Academy of Engineering Sciences (IVA). Lövgren, Britta (1993). *Hemarbete som politik: diskussioner om hemarbete, Sverige 1930-40-talen, och tillkomsten av Hemmens forskningsinstitut*. Stockholm: Stockholms Universitet.

³⁴ Schantz, Peter (2015). "Along paths converging to Bengt Saltin's early contributions in exercise physiology", in *Scandinavian Journal of Medicine and Science in Sports*, 25(Suppl. 4), pp. 7-15. Renström, Per and Karlsson, Jon (2003). "En resa i tiden med svensk idrottsmedicin", in *Svensk idrottsforskning*, 2010:3, pp. 4-9.

to the much-needed discussion on relations between science and other forms of knowledge (practical, tacit, embodied, experiential and traditional) that faced challenges from the scientization of sports.

Demarcations

My primary interest has been in the meeting between science and skiing and the development of training, but this subject has ties to a lot of other interesting aspects of sports history and history of science and technology. I will therefore briefly discuss some such aspects, which are not part of the core of this dissertation but definitely belong within the context in which the results should be understood.

It would have been fruitful to look deeper into the impacts of and ideas behind technological development in cross-country skiing (especially since I have conducted this research at a technological university). As a sport more dependent on equipment than many others, cross-country skiing has dramatically changed through technology. Machine-made tracks made upper-body and arm-strength more important, because double-poling is now much more frequent than it used to be. Skiing in the man-made tracks of the 1940s was a balancing-act, and much more of the effort came from the legs. When roller-skis were introduced (1950s) and became popular (1970s), less running was needed in the summer. Training became more specialized, partly through technology. One could also discuss the somewhat floating line between science and technology in cross-country skiing. Some aspects of what the physiologists at GCI did could be described as technology (e.g. the construction of ergometers), while other work lies closer to basic research. I will not go further into this discussion here, but it is worth noting that there is no clearly defined line between technology and science in relation to skiing.

The development of ski wax has also come a long way, from the early attempts during the first decades of the 20th century (a couple of notable examples are the Norwegian “klistert” introduced in 1913 and the launch of the Swedish Martin Matsbo wax in the 1940s) to the high-tech approach of today’s elite skiers.³⁵ This technological progress has developed the sport, but also accelerated some problems. In the context of sustainability discourse, the ecological footprint of the skier who in the 1930s put his wooden skis on for a three-hour combined training/hunting session was probably much less than the ecological footprint of the modern elite skier with their plastic skis, fluorite-based (and potentially health-threatening) ski wax, and trips across the world for training and competition. The rationalization of skiing (and sports in general) has not been unproblematic, but while technological impacts on sports are an aspect related to this dissertation, I have limited my study to the question of training and its knowledge base. This cannot always be separated, however, as changes in technology (such as machine-made tracks) have changed the way skiing is performed and thus what kind of skills are needed to compete at the highest level. I will return to this issue throughout the dissertation, but the role of technology will have to be explored in greater depth in future research. Meanwhile, there are already efforts that address the role of technology in sports.³⁶

Another issue connected to the topic of this dissertation is doping, perhaps the most rationalized, most scientific way of preparing the body for extreme performance. Ironically (or perhaps only logically),

³⁵ The International Skiing History Association (ISHA). Masia, Seth. “Grip and glide: a short history of ski wax”. <<https://www.skiinghistory.org/history/grip-and-glide-short-history-ski-wax>>. Retrieved 2016-07-04. See also: Vaage, Jakob (1977). *Skismøringens historie*. Skårer: Swix Sport International. Gotaas, *Først i løypa*.

³⁶ Haake Steve (2009). “The Impact of technology on sporting performance in Olympic Games”, in *Journal of Sport Sciences*, 27.13 (2009), pp. 1421-1431.

Sweden's leading physiology division was not only responsible for ground-breaking sports science such as carbohydrate loading, but also for what is now known as blood doping. Björn Ekblom's discovery in 1972 obviously was not intended to provide a means for athletes to cheat, but that is how the knowledge has been used by some.³⁷ From a scientific point of view, Ekblom's research was cutting-edge basic physiology, while from a sports perspective it was either disturbing or promising (depending on the athlete's own ethics). Ekblom himself realized the implications and raised concern over how this new knowledge could be put to the wrong use.³⁸ This history of blood doping shows the ambivalence of sport-related physiology. On the one hand, the research conducted at GCI was seen as basic physiology and, as such, knowledge was the goal, regardless of what that knowledge could be used for. On the other hand, the researchers at GCI had a long record of promoting their results for application in sports and as Ekblom's article shows, they were aware of the potential impacts of their findings in elite sports. Bearing this in mind will help in the reading of my articles, as the balance between basic and applied science is discussed in several of them. That said, doping will not be in focus here. It is a subject that deserves full attention and one that has received such attention from leading scientists and historians of science and sports, including John Hoberman.³⁹

In a couple of the articles in this dissertation I use Michel Foucault's theories of bio-power and disciplining to explain the ideology behind scientization of training. Doping can be seen in this light as an extreme example of bio-power, and there have been attempts to frame doping using Foucauldian theories on power.⁴⁰ For the purpose of this dissertation, it is enough to note that the impact of GCI physiologists in sports has been huge, and had various effects. Doping is a dead end in the rationalization of training, because it breaks with the rationale of sports (e.g. fair play, equality, regulation). Doping is left out of this dissertation also for temporal reasons: the period of study here is approximately 1930-1980, while doping became a more visible issue in the 1980s and 1990s.

The reason to start with the 1930s is that it was a time of rapidly increasing scientific interest in sports. Harvard Fatigue Lab (one of the most important centers of sports-related physiology research) was established in 1927, and gained momentum in the 1930s. Across the world, scientists started to take interest in the physiology of athletes and their potential as test subjects and role models. There is no specific end to this development. However, with the introduction of *skidgymnasium*, special upper secondary school educations for elite athletes established in Sweden in the early 1970s, professional and specialized coaches, and the rapid developments in doping during the 1970s and 1980s, a new era of broad scale implementation of scientized training had begun. The scientization process had, to use vocabulary from science and technology studies (STS), reached closure, at least in terms of being implemented as the official training regime. This dissertation is focused on the role that science played in training, especially during the years 1940-1970. This is the time period in which physiology entered the world of elite sports, and changed it profoundly. In Swedish cross-country skiing, it is also the period when the power of definition of what kind of training was most effective and relevant shifted from the skiers to the scientists.

³⁷ Ekblom, Björn and Huot, Roger (1972). "Response to Submaximal and Maximal Exercise at Different Levels of Carboxyhemoglobin", in *Acta Physiologica Scandinavica*, 86(4), pp.474-482. Ekblom, B., Goldbarg, A. N., Gullbring, B. (1972). "Response to exercise after blood loss and reinfusion", in *Journal of Applied Physiology*, 33(2), pp.175-180.

³⁸ Ekblom Björn (1972). "Will Blood Doping Become a New Sport Problem?" [Swedish title: "Blir 'blod-doping' ett nytt idrottsproblem?"], in *Svensk Idrott*, 1972:11, pp. 293-295.

³⁹ Hoberman, *Mortal Engines*. See also: Thieme, Detlef and Hemmertsbach, Peter (eds.) (2010). *Handbook of experimental pharmacology, vol. 195, Doping in sports*. Berlin: Springer. Yesalis, C.E. and Bahrke, M.S. (eds.) (2002). *Performance-Enhancing Substances in Sport and Exercise*. Champaign, IL: Human Kinetics.

⁴⁰ Kimura, Machiko (2003). "The genealogy of power: historical and philosophical considerations about doping", in *The International Journal of Sport and Health Science*, 1:2, pp. 222-228.

How the study was conducted – methods and other considerations

This research sets out to investigate the change in training methods and ideologies⁴¹ during the 20th century. I have mainly used three methods – interviews, text studies, and auto-ethnographic field studies. These will be presented below.

The case study has been Swedish cross-country skiing from the 1940s. It may seem like a very particular case study, but I argue that many of the experiences from this development are possible to transfer into other sports and areas of society.

Training knowledge in skiing has been built by three major groups of actors: scientists, skiers and coaches. The scientific interest is perhaps the less obvious one, so I started out by investigating the scientists and their ambitions with involving themselves in skiing. I used archival research, studying the correspondence and internal documents of the physiology department at GCI. I also looked at the publications from GCI physiologists from the 1940s until the 1970s, to get an overview of their ambitions, funding and methods. Finally, I interviewed a few of the leading physiologists from GCI (among them Bengt Saltin and Per-Olof Åstrand).

The next step was to understand the ambitions of the athletes and the Swedish Ski Association (SSF) and how skiers, SSF board members and employees and physiologists interacted in the scientific turn of training. For this purpose I studied the archives of both GCI and SSF, and the personal collections of former SSF chairman Sigge Bergman.

I have conducted interviews with elite skiers active during the 1950s, 1960s and 1970s, as well as scientists involved with the Swedish national team during that period. These interviews have been semi-structured, meaning that a set of prepared questions about training was used as a starting point for all the interviews, while allowing for the discussion to divert from the questions based on what the interviewed person said.⁴² Twenty elite skiers (thirteen men and seven women) that have represented the Swedish national team were interviewed. The gender unbalance of the interviews reflects the gender unbalance in the Swedish national ski team during the period of study. I have been rather pragmatic in my selection of whom to interview, based on who was still healthy enough to participate. Some skiers could not be reached, and others did not want to participate. There is of course a risk that you get people of similar views to participate, while those who hold contrasting views refuses to be interviewed. However, the diversity of geographic background, age and gender, as well as the rich variety of opinions about scientific involvement, suggests that the skiers interviewed represent fairly well the skiing community at the time.

Because the skiers and physiologists were interviewed about events that took place up to 60 years ago, some level of caution has to be present when drawing conclusions based on this empirical data. For skiers that have not been available for interview, autobiographies have been used instead. I would argue that even if such sources are printed and therefore in some way more reliable, they may also

⁴¹ I occasionally use training ideology as an alternative to training methods in this dissertation. The reason is that both *rational training* and *natural training* were more than practical methods for training. They carried with them ideological connotations that linked to epistemology, ideas about bodies and nature, political views and more. The ideas about training discussed here are given more justice when labeled as ideologies, in which training methods was one aspect.

⁴² For more details regarding semi-structured interviews, see: Wengraf, Tom (2001). *Qualitative research interviewing: biographic narrative and semi-structured methods*. Thousand Oaks, Calif.: SAGE.

represent an idealized image of a career and they operate in a book market aimed at selling books rather than presenting historically accurate accounts.

I have also studied the handbooks, or training manuals, published by the SSF and distributed to elite skiers and talented youngsters. These handbooks reflect the change in training ideology and can be followed chronologically from the 1940s until today. For the article on high-altitude training, the archives of Harvard Fatigue Laboratory was an important source. In the piece on landscapes of skiing as cultural heritage, the sources listed above were complemented with current marketing texts from the tourism industry in the landscapes of interest (Vasalopp Arena, Hindås, Vålådalen).

Finally, I have used an element of field studies, or what I would rather like to call auto-ethnographic training studies, in order to better understand the information from other sources (a method commonly used in ethnography and sociology).⁴³ I visited Vålådalen, Falun and Åsarna, and ran along the mountain paths that Olander used as inspiration for his training program. I skied in the Vasaloppet Arena, in the footsteps of the skiers I have interviewed and read about. I went to the lab to test my max pulse, VO₂ max and lactic acid threshold, did research and was researched at the same time. Being in those landscapes and labs, performing the tests and training activities (though at much lower speed and with horrendous technique), has added something to my understanding of the history of training. This auto-ethnographic methodology has not been a primary source of empirical data, but rather a way to put things in perspective, for “directly linking the micro level with the macro cultural and structural levels” as Jacquelyn Allen-Collison and other scholars of different disciplinary background have done in relation to sports and training.⁴⁴ In research that in some way relates to the body, the inclusion of the researcher’s own body and bodily experience in the research process seems less strange than the opposite would. There are also several recent examples of how auto-ethnographic accounts of the body have been used to analyze illness, weakness and pain, such as Sverker Sörlin’s *Rädslan för svaghet*.⁴⁵ Recent research indicates that auto-ethnography is a method that is increasingly used. There are obvious benefits of the resulting personal experience and thick narratives, while there also exist potential pitfalls of auto-ethnography if it only produces such personal narratives and fails in putting them into context and analyzing them socio-culturally.⁴⁶

In ways that perhaps are less visible in the articles, my own experience of different landscapes and training methods has helped me understand what a skier was actually talking about when they said they went numb after 20 kilometers, or became nauseous during a race because they had eaten something their bodies were not used to. The auto-ethnographic aspects of this dissertation are primarily such that they have helped me in choosing from a vast material. Without personal knowledge of running and skiing, it would have been an almost impossible task.

As the reader will have noticed by now, the methodology that I have engaged for this dissertation has been pluralistic, even eclectic. It has provided a broad range of source material, representing all the

⁴³ E.g.: Coffey, A. (1999). *The Ethnographic Self: Fieldwork and the Representation of Identity*. London: Sage. Roth, Wolff-Michael (ed.) (2005). *Auto/biography and auto/ethnography: praxis of research method*. Rotterdam: Sense Publishers. For a form of auto-ethnography which lies closer to traditional ethnographic research, see: Anderson, Leon (2006). ”Analytical Autoethnography”, in *Journal of Contemporary Ethnography*, vol. 35 no. 4, pp. 373-395.

⁴⁴ Allen-Collinson, J (2013). “Autoethnography as the engagement of self/other, self/culture, self/politics, selves/futures”, in S Holman Jones, T E Adams & C Ellis (eds), *Handbook of Autoethnography*. Walnut Creek, CA: Left Coast Press, p. 283.

⁴⁵ Sörlin, Sverker (2014). *Rädslan för svaghet: en berättelse om sjukdom, smärta och löje* [English title: The fear of weakness]. Stockholm: Weyler.

⁴⁶ Chang, Heewon (2016). “Autoethnography in Health Research: Growing Pains?”, in *Qualitative Health Research*, vol. 26 no. 4, pp. 443-451.

important groups of actors in Swedish cross-country skiing. It has also allowed for the cross-checking of records and information. Therefore, even though there may be problems with all of the different types of sources, this analysis has taken the multitude of actors and perspectives into account.

Key concepts

This dissertation contains several key concepts which I will discuss in detail below. These are: training, endurance sports, *rational training* and *natural training*.

The history of training in cross-country skiing (and in endurance sports in general) is in essence a story about the level of scientific involvement. From the early days of natural training (or no specific training at all) to the scientifically grounded training we see today, there has been a discussion about how training should be organized and what type of knowledge should be valued the most: scientific or experiential (i.e. based on personal, lived experience). In the following, there will be a discussion of some of the key concepts that we need to understand if we are to analyze the changes in training over the last 100 years. But let us first look at a brief summary of this development.

In a sense, people have always been ‘training’. At least in the sense that is described in the *Swedish Academy Dictionary*, namely education to attain, maintain and improve a certain ability or skill. All practical work builds on such experiential education. There is also a long history of exercise to prevent or cure disease and bodily decay, dating back at least to Ancient India, Greece and Rome, where physicians recommended daily exercise for reasons of health.⁴⁷ But if you add the second part of the Swedish Academy Dictionary definition, which relates training to the gradual increase of performance level, training is a much more recent innovation.⁴⁸ The first mentions with those connotations in Swedish written sources can be found in the late 19th century: Some with reference to the (military) training of horses, others describing the importance of training as preparation for athletic performance and as a means of avoiding overtraining the body. In 1882, *Tidning för idrott* called training a “correct preparation for exertion”.⁴⁹ It is striking that the earliest accounts of the word training in Swedish refer to military activities, as well as civil competitions. This double interest for training and training-related science was a key factor in securing funds and legitimacy at the world-leading centers of physiology, such as The Royal Central Institute of Gymnastics in Stockholm or the Harvard Fatigue Laboratory, during the 20th century.⁵⁰ The continued co-dependency between science, sport and military is further described in the article about high-altitude training.

⁴⁷ Tipton, Charles M. (2014). “The history of ‘Exercise Is Medicine’ in ancient civilizations”, in *Advances in Physiology Education*, 38:2, pp. 109-117.

⁴⁸ In Swedish: “*rigtig förberedelse till en ansträngning*”. *Swedish Academy Dictionary* online, search phrase: träna. <<http://www.saob.se/fritextsok/>>.

⁴⁹ *Swedish Academy Dictionary* online, search phrase: träna. <<http://www.saob.se/fritextsok/>>.

⁵⁰ For GCI, see: Åstrand, Per-Olof (1988). “Fysiologiska institutionens tillkomst och utveckling”, in Halldén, Olle (ed.), *Festskrift vid GCI-GIH:s 175-årsjubileum*. Stockholm: Gymnastik- och idrottshögskolan. Schantz, ”Along paths converging to Bengt Saltin’s early contributions in exercise physiology”. For Harvard Fatigue Lab, see: Little, Michael A., Thomas, R. Brooke and Garruto, Ralph M. (2013). “A Half Century of High-Altitude Studies in Anthropology: Introduction to the Plenary Session”, in *American Journal of Human Biology*, nr. 25, p. 148, and Folk, G. Edgar and Thrift, Diana L. (2010). “The Harvard Fatigue Laboratory: contributions to World War II”, in *Advances in Physiology Education*, 2010:34, p. 119, 125-126.

Cross-country skiing is the focus of this dissertation, but most of the science behind *rational training* and most of the ideas behind natural training have been of importance in other sports as well. Mainly in endurance sports, i.e. sports that require a steady and heavy workload over relatively long timespans (cross-country skiing, long-distance/fitness running, orienteering, cycling, rowing, triathlon). These sports have in common certain requirements on the athlete, such as a high maximal oxygen uptake, VO_2 max, and the ability to endure high levels of lactic acid. These sports also relate to nature, in that the most common setting for training has been in natural surroundings such as forests, mountains and fields. Endurance was also a key factor for the physiologists at GCI. It was endurance (i.e. the ability to drive oneself to exertion, to perform at a high level over long timespans and to resist fatigue) that they wanted to increase, and had the science to do so. It was the most important aspect of skiing for both scientists and skiers. Still, endurance sports is not a perfect definition. There are sports where endurance and a high VO_2 max are key that are totally different from cross-country skiing in other ways, e.g. swimming or skating. There are also other sports that have a strong connection to the landscape, as does cross-country skiing, but lack the endurance aspect (e.g. golf). In this dissertation, endurance sports refers primarily to the sports cross-country skiing, long-distance/fitness running, orienteering, cycling, rowing and triathlon. These are also listed as endurance sports (*konditionsidrotter*) by leading Swedish physiologists, who define endurance in terms of high VO_2 max.⁵¹

If we now look closer at the history of endurance training, some general developments can be noted. As in other sports, skiing follow the basic trajectory of the sportification theory (discussed in detail in the following sections). According to this, all sports develop in similar, predictable ways, becoming more rational, systematic, organized, and professional.⁵² It is no coincidence that the motto of the Olympic Movement is *Citius, Altius, Fortius* (Latin for Faster, Higher, Stronger).⁵³ The motto implies improvement and increased performance, and sportification is the tool with which the motto is pursued.

For a sport like cross-country skiing, this has meant that the distances of ski races have been standardized and carefully measured (10 kilometers, 30 kilometers, 50 kilometers etcetera) while earlier races such as Birkebeinerrennet in Norway or Vasaloppet in Sweden were not primarily designed for an exact distance, rather for a historically anchored manifestation of strength and nationalism.⁵⁴ Sportification has meant that the regulations on style and equipment have become ever more rigorous, to the extent that skate skiing has become a separate event, while it had historically on occasion been practiced in the classic ski competitions until the success of American skier Bill Koch in the 1982 International Ski Federation (FIS) World Championships.⁵⁵ The treatment of the new style of skiing by FIS – to separate it from the traditional practice of skiing with increased regimentation, specialization and equalization – is precisely what sportification theory points at.

⁵¹ Mattsson, Mikael C. and Holmberg, Hans-Christer (2012). "Intervallträningen som ger guld" in *Svensk Idrottsforskning*, 2012:2, p. 44.

⁵² E.g. Yttergren, *Täflan är lifvet*, p. 21-22. Guttmann, *From Ritual to Records*, p. 54-55. Goksöyr, *Sivilisering, Modernisering, Sportifisering*.

⁵³ Olympic.org, "The Olympic symbols".

<http://www.olympic.org/Documents/Reports/EN/en_report_1303.pdf>.

⁵⁴ Sörlin, "Nature, Sking and Swedish Nationalism".

⁵⁵ Early records of skate skiing in international competitions date back to at least the 1930s: Bø, Olav (1993). *Skiing throughout history*. Oslo: Norske Samlaget. For a record of how skating was dealt with, see: The International Skiing History Association (ISHA), official website. Bengtsson, Bengt Erik (n.d.). "Cross-country skating: how it started". <<https://www.skiinghistory.org/history/cross-country-skating-how-it-started>>. Retrieved 2016-05-01.

Sportification has meant that the issue of high-altitude — intensely debated around the Olympic Games held in Squaw Valley 1960, Innsbruck 1964 and, especially, Mexico City 1968 — has been increasingly regulated by the governing bodies of sports. When physiological research indicated that high-altitude training was advantageous for endurance athletes, the rules surrounding such training and competitions at high altitude were articulated and specified by the governing organizations of international sports in order to defend the universal values of equalization and regimentation of elite sports. It was another step away from the local (in this case local condition) towards the universal (comparability of results over time and space).⁵⁶

Sportification has also meant a professionalization of the skier, from the amateurs of the early 20th century through the semi-professionals of the 1970s and 1980s to the full-time professionals of today. In the early 20th century, endurance training was still a private matter, something which the athlete engaged in according to personal, experiential and local knowledge. Endurance athletes were more and more recruited from the ranks of forestry workers and others from the rural population who had a heavy physical workload in their daily life. The early developments in this regard caused frustration in the cross-country skiing community, as it was feared that large numbers of skiers would be excluded from winning races if the amount of preparation time (training) increased. Norwegian skiers argued that professionalization was a threat, and that those who could spend a great amount of time on training gained an unfair advantage (while we today talk admiringly about those who spend 1000 hours per year on training).⁵⁷ Similar protests were heard in other countries, but they could not stop this development.

Training became increasingly organized. National federations tried to take control over training via instruction manuals and training camps. Training became a year-round activity, with increasing emphasis on the summer season. In terms of actual training methods, novelties such as the Swedish *fartlek* ('speed play', a kind of spontaneous interval-like training) were introduced in the 1940s and became well-known internationally among endurance athletes.⁵⁸ More strictly timed interval programs were also introduced, mainly out of the German training culture.⁵⁹ In the 1950s and 1960s, specialized upper-body strength gradually replaced the work-related strength of the forestry-working skier.

Innovations such as bicycle ergometers (1940s), roller-skis (first introduced in the 1950s) and high-altitude training (1960s) enabled a much more specialized training, as opposed to the generalist endurance training of the early 20th century. With the innovations in self-monitoring during the last 30 years, training has become rationalized in a way that hardly could have been predicted even by the physiologists themselves. Pulse watches, lactic acid thresholds and machine-made ski tracks have underlined the shift from natural to rational. However, there is also a parallel trend. Bare-foot running and trail-running are becoming popular (and popularized) with ideas closer to the natural training tradition.⁶⁰ There seem to be no end of training history, and as a field of academic interest, it is still quite young.

⁵⁶ Kasperowski, Dick (2009). "Constructing Altitude Training Standards for the 1968 Mexico Olympics: The Impact of Ideals of Equality and Uncertainty", in *The International Journal of the History of Sport*, 26:9, p. 1280.

⁵⁷ Sandbakk and Tønnessen, *Den norske langrennsboka*, p. 14-15.

⁵⁸ Holmér, Gösta (1943). *Vägen till rekorden: instruktionsbok i fri idrott*. Stockholm: Swings sportdepå.

⁵⁹ Yttergen, *Träna är livet*, p. 132-133. See also: Krüger, Arnd (2006). "Training Theory and Why Roger Bannister was the First Four-Minute Miler", in *Sport in History*, 26:2, pp. 305-324.

⁶⁰ E.g. McDougall, Christopher (2009). *Born to run: the hidden tribe, the ultra-runners, and the greatest race the world have ever seen*. London: Profile Books.

In the history of rationalization of training, sports is, perhaps in a sense that may seem contradictory, just one of several outputs of a broader, basic research on physiology. Physiologists like David Bruce Dill at Harvard did not primarily take an interest in developing their contribution to elite sports, but rather focused on other applications in physical education and military service.⁶¹ The athlete was used as a test object, and the results were believed to be transferrable to workers, soldiers and others.⁶² The same is true for the world-renowned “sports scientists” at GCI that are studied in detail in one of my articles. They contributed enormously to sports and training, but saw themselves as primarily doing basic research in physiology, applicable in a wide range of physical practices.⁶³ The tendency among leading physiologists to downplay their role as sports scientists, and focus instead on their contributions to basic research, should not be taken as a review of their outcomes, but rather of their intentions. GCI physiologists like Per-Olof Åstrand and Bengt Saltin have made huge contributions to training and sports, but their legacy is not limited to this. In retrospect their work may be framed as sports science, but in the early phases of their careers such a field did not exist, at least not in name. That brings us to the issue of what we call things, and what meaning we invest our nomenclature with.

The history of training contains a few key concepts and ideas. Therefore this dissertation in some parts lies close to conceptual history in order to explain and understand how the key concepts of training have changed in ideology and meaning during the 20th century. Conceptual history, as outlined by Reinhart Koselleck and others, highlights conflict and crisis as fruitful areas of historical study.⁶⁴ Where a meaning of a concept has been in contest, different groups of interest have tried to frame the concept according to their ideology and practice. This is in essence what happened with the concept of *rational training* within the context of cross-country skiing.

As the title of this dissertation indicates, this is a history of *rational training*. I use this term not as a judgment of the scientific training model but rather as a descriptive tool to frame the content and ideology of the physiologists that advocated rational training. Perhaps rationalist would be an even better word. Both are used in the articles that constitute this thesis. *Rational training* was a concept that skiers and other endurance athletes started using during the 1930s, but at that time it was still basically a synonym for structured, planned training. Gradually, the meaning of the word was changed as physiologists and their supporters gained power over the training discourse. The word rational (*rationell* in Swedish) can be found in Swedish written sources from 1745. However, it is not until the late 19th century that the word rational is connected to training. First to Ling gymnastics — which was to be attacked precisely for its lack of rationality — by physiologists in the 1940s.⁶⁵ Later it also referred to other forms of training, but *rational training* as a way of describing a training method did not begin to spread until the 1930s, when, for example, elite skier Mora-Nisse Karlsson claimed he had been training rationally since his late teens.⁶⁶ By this he meant systematically, and according to best available practice. But the physiologists meant something else, namely a scientifically based training method with universal applicability. Rationality was prestigious in the first half of the 20th

⁶¹ Horvath, Steven M. and Horvath, Elizabeth C. (1973). *The Harvard Fatigue Laboratory: Its History and Contributions*. Englewood Cliffs, NJ: Prentice Hall.

⁶² Wolfe Scheffler, Robin (2015). “The Power of Exercise and the Exercise of Power: The Harvard Fatigue Laboratory, Distance Running, and the Disappearance of Work, 1919–1947”, in *Journal of the History of Biology*, 2015:48, p. 416.

⁶³ Svensson, Daniel (2013). “How Much Sport is there in Sport Physiology? Practice and Ideas in the Stockholm School of Physiology at GCI, 1941–1969”, in *The International Journal of the History of Sport*, vol. 30, no. 8, pp. 892-913.

⁶⁴ Koselleck, Reinhart (2002). *The practice of conceptual history: timing history, spacing concepts*. Stanford, California: Stanford University Press.

⁶⁵ Swedish Academy Dictionary online, search phrase: rationell. <<http://www.saob.se/fritextsok/>>.

⁶⁶ Karlsson, Nils (1953). *I vita spår*. Stockholm: Bonnier, p. 108, 113.

century in Sweden; a way of signaling exactness, predictability, trustworthiness and seriousness, a buzzword used by leading ideologists, politicians, scientists and authorities.⁶⁷ It was used as a positive judgment, in a similar way that we now use professional (which was then used as an insult rather than as something positive).

By using basic physiology methods to examine elite athletes, they built a knowledge base for rational endurance training. Training methods such as timed intervals and pulse training were results of this knowledge, but the scientists also affected the context of training. For example, they made scientific testing a mandatory feature in being a national team skier. They had a say in things like high-altitude acclimatization, the level of glucose in water distributed at competitions, carbohydrate loading and rest periods. This development was most clearly seen in the training manuals published by the Swedish Ski Association. When physiologists took over the duty of writing these manuals, the advice on training changed dramatically. In the 1962 edition, the previous model of natural training (described in detail below) was replaced by a focus on intervals and scientific testing.⁶⁸ In 1970, the training theory was built on scientific nomenclature and the training manual had charts with oxygen uptake and other data on test subjects.⁶⁹ In 1974 the training manual included a chapter on scientific testing as an important tool for skiers to compare performances from training sessions in different landscapes.⁷⁰ Swedish cross-country skiing had been rationalized, at least in theory.

Second, we have the method of *natural training*. Unlike *rational training*, it was never widely used by sport practitioners. I use *natural training* as a description of how earlier training models focused on the relation between body and landscape, and the skepticism towards any mechanistic, unnatural regulation of training, body and nature. Thus, in this thesis the concepts of *natural training* or *rational training* are analytical tools rather than philosophical judgments. No training can ever be objectively rational or natural. Training is political, and the ideas behind it reveal a lot about socio-economic and ideological contexts.

Still, if we are to analyze changes in training over time it is useful to identify some key characteristics of the different training traditions. *Natural training*, to a much larger extent than *rational training*, relates to landscape. In this dissertation, landscapes that have been deeply affected by training and sports are labeled *landscapes of mobility*. Such landscapes are characterized by a long tradition of training-related human movement, and the remains of this movement (skiing tracks, running paths, flood-lit tracks, signs, nomenclature inspired by sport history) constitute a *movement heritage*.⁷¹ In certain areas of Sweden, such heritage has been carefully articulated and used to attract tourism while also functioning as areas of nature preservation (e.g. Vålådalen, Vasalopp Arena). These landscapes have been framed as genuine places for skiing, and continue to attract skiers in large numbers. They thus place themselves in the tradition of *natural training*, as advocated by the Swedish endurance coach Gösta Olander, manager of the Vålådalen Alpine Station.

Olander argued, and became famous, for a training regime that was firmly rooted in nature. The landscapes of training, which for the physiologists mainly caused problems of comparability, were for

⁶⁷ Hirdman, Yvonne (2010). *Att lägga livet till rätta*. Stockholm: Carlsson Bokförlag, p. 254-256 et passim.

⁶⁸ Briandt, Calle (1962). *Träningsråd i längdloppning* (English title: Training advice for cross-country skiing). Stockholm: Swedish Ski Association.

⁶⁹ Swedish Ski Association (1970). *Åk skidor*. Täby: Larson, p. 11-13, 18-23 et passim.

⁷⁰ Bergh, Ulf (ed.) (1974). *Längdloppning på skidor: träningsråd* (English title: Cross-country skiing: training advice). Bjästa: CeWe-förlaget, p. 55.

⁷¹ A concept first used and elaborated in the following article: Svensson, D., Sörlin, S. and Wormbs, N. (2015). "The movement heritage – scale, place, and pathsapes in Anthropocene tourism", in Gren, Martin and Huijbens, Edward (eds.), *Tourism and the Anthropocene*, London: Routledge, pp. 131-151.

Olander the key to success. He favored long training sessions in mountains and forests, saw walks and hunting as part of build-up training, and was critical of attempts to base training on science rather than experience.⁷² In this, he was certainly not alone. Famous coaches such as the Australian Percy Cerutti also argued for a holistic, natural training setup.⁷³ *Natural training*, as understood by Olander, Cerutti and their followers, was built on personal knowledge and had no universal claims. Still, they had ambitions to spread their ideas about training in the sports community, and were both rather successful in doing so.

Olander held the Sami as role models for skiers. He admired their ability to move swiftly through the mountain landscape in both summer and winter, and argued that much of their ability in skiing came from their reindeer herding practices.⁷⁴ In the first skiing competitions in Sweden, Sami skiers were successful. Sportification of skiing changed the role of skiing in general, but perhaps even more so in the Sami areas where skiing went from being a part of everyday work to a sport in just a few decades.⁷⁵ Forestry had a similar role for many Swedish skiers. The sportification process, especially the scientization and specialization of training, made reindeer herding, forestry and other similar practices more or less redundant as training for elite athletes. The experiences from this type of physical work during long periods remained, however, an important aspect of *natural training* ideology, manifested through the Norwegian concept of long low-intensity training sessions, *rolig langkjøring*.⁷⁶ In fitness running, triathlon and other similar endurance sports, it is known as Long Slow Distance.

Natural training built on ideas in which the relation between landscape and body was fundamental. In many ways, the natural was a rhetorical thing more than a practical one. Olander and others were not so different from many of their contemporaries with a more scientific approach.⁷⁷ Rhetoric, however, also indicates something. Natural training resonated of earlier attempts by fascists, conservatives and even environmentalists to link nation, body and landscape.⁷⁸ At the same time, *natural training* fit well with the rhetoric surrounding other sports where landscape and non-sportified practice plays a large role, such as surfing, climbing and snowboarding.⁷⁹

As is hopefully made clear by what has been stated so far, I use the concepts *natural training* and *rational training* both as study objects (as they are occasionally used in sources) and as analytical tools to mark the differences between scientifically based training and training based on personal knowledge and experience. The differences between natural training and rational training follow other developments in society (e.g. rationalization, scientization); to clarify the 20th century shift from experience-based, natural knowledge to rational, science-based knowledge, I will use the model

⁷² Olander, Gösta (1948). *Träningsråd för skidåkare*. Stockholm: Svenska skidförbundet. Yttergren, *Träna är livet*, p. 85-89.

⁷³ Howe, "Habitus, Barriers and the [Ab]use of the Science of Interval Training in the 1950s".

⁷⁴ Olander, *Träningsråd för skidåkare*, p. 4.

⁷⁵ Pedersen, Helge Chr. (2013). "Skiing and Sport in the Core Sámi Area of Norway, 1927 to 1964: Organisation, Modernisation and Minority Policy", in *The International Journal of the History of Sport*, vol. 30, nr. 6, pp 580-597.

⁷⁶ Sandbakk and Tønnesen, *Den norske langrennsboka*, p. 29. See also: Sörlin, *Kroppens geni*, p. 29 et passim.

⁷⁷ Krüger, "Training Theory and Why Roger Bannister was the First Four-Minute Miler".

⁷⁸ E.g. Sörlin, "Nature, Skiing and Swedish Nationalism" and Armiero, Marco (2011). *A Rugged Nation: Mountains and the Making of Modern Italy: Nineteenth and twentieth centuries*. Knapwell, Cambridge: White Horse Press.

⁷⁹ Dumont, Guillaume (2014). "Aesthetics of attachments: Reflexive insights on taste construction in climbing", in *European Journal for Sport and Society*, 11:4, pp. 371-387.

below. It depicts two types of knowledge that are crucial in the history of training in cross-country skiing, and sports in general.⁸⁰

Natural experiential knowledge	Rational scientific knowledge
Pre-modern	Modern
Personal/private	Professional
Individual	Universal
Local	Global
Auto-didactic	Formal education
Secret	Open access
Trial and error	Hypothetic, deductive
Expert and practitioner	Expert is not a practitioner
Embodied, tacit knowledge	Written knowledge

These are some of the key characteristics of knowledge in sports that have changed during the 20th century. Of course, this is a stylized description, an ideal type in Max Weber's terms, and things are never this easy and distinct. Yet, this model can help explain why there were problems in the interaction between skiers and scientists. The ideas about training, the role of personal experience and the possibility of universal knowledge differed greatly.

It is possible to also add a third column, where many of the dichotomies of the previous two have merged. Post-modern training knowledge is both scientific and experiential, and has turned back towards a more individual approach. All elite training today builds to some extent on a scientific base, mainly from physiology. That said, there is now a better understanding of how complex each individual body is, and that the universality of training theories cannot be taken for granted even if it is built on solid scientific ground.

Theories

In the articles comprising this dissertation I use a number of theoretical approaches, more precisely sportification, rationalization, Michel Foucault's theories of *bio-power*, Ruth Oldenziel's theory on *mediation junctions*, and Sverker Sörlin's theory on *articulation of territory*. Most of these are presented in detail in the respective articles, but a few words about theory are due in this introductory chapter as well. The theory most visible is the sportification theory. I present it in a separate section below, while a brief presentation of some other important theoretical inspirations will follow here.

⁸⁰ The model (which I have slightly adjusted) was first suggested by Jonny Hjelm, Department of Historical, Philosophical and Religious Studies, Umeå University, when he served as opponent for the final seminar in my research education, May 16th 2016 at KTH Royal Institute of Technology.

In several of the articles I use concepts and theories of Michel Foucault, as well as interpretations and developments of his thinking. While I am not entirely convinced about the omnipotence of his structuralist perspective, his work on disciplining and bio-power, i.e. the efforts of modern powers to control as many aspects of the living human being as possible through a range of techniques and strategies to control and rationalize human life, fit well with the rationalization of training during the 20th century.⁸¹ Measurements, (self-)surveillance, maximizing performance and control over behavior (in this case training) are all important aspects of disciplining and bio-power, a power that “brought life and its mechanisms into the realm of explicit calculations”.⁸² This is, to name but two examples from the world of sports, what happened when the non-scientific, playful training method “fartlek” stood against the more scientific approach with exact, timed interval training in the 1930s, or when the traditional rest periods from forestry due to the seasonality of the job was gradually replaced by a scientific periodization of training and resting in the 1960s and 1970s. According to Foucauldian thinking we have seen a gradual shift from a repressive power, via a disciplining power, to bio-power. The latter is an internalized form of control, not primarily performed by governing organizations, states or others, but rather regulates behavior through self-censorship.⁸³ Rational training started out as a scientific product, which was then gradually internalized in the athletes through a process of disciplining by scientific institutions, governing bodies of sport, specialized upper secondary schools for elite athletes, and regimentation of sport through international federations and associations like the International Ski Federation (FIS). Being an elite athlete is in many ways about self-control and has been so historically as well. But the level of self-control, and its content, has changed, from the agitated resistance to stopwatches and scientific testing in the 1950s to the point where we now willingly upload our biometrical data to social media through the self-monitoring technologies carried on our bodies.

The advances in what Foucault labeled bio-power are also due to the role of international sport organizations, such as FIFA or IOC (or in the case of cross-country skiing, FIS). These have been important for the sportification process because “international sport organizations standardize the forms of sports and consistently improving telecommunication networks increases the exchange of sport research and information”.⁸⁴ It is through the organizations of sport that the scientization of training has been possible. The Swedish Ski Association played a vital role in the case of Sweden, and later Swedish representatives played a similar role within FIS and IOC.⁸⁵ The discussion about scientific training seems more visible in international contexts, and while more research is needed as for why this is the case, my hypothesis is that the principles of sport (competing on equal terms) makes the access to certain knowledge a key issue when nations stand against each other.

I also use the theory of mediation and *mediation junctions* inspired by Ruth Oldenziel’s research on dissemination and negotiation of technology and science.⁸⁶ One major problem in the scientization of

⁸¹ Foucault, Michel (1998). *The Will to Knowledge. The History of Sexuality, Vol. 1*. New York: Penguin Books, p. 140-144.

⁸² Foucault, *The will to knowledge*, p. 143.

⁸³ Edwards, Allan and Skinner, James (2006). *Sport Empire*. Oxford: Meyer and Meyer Sport, p. 36-37.

⁸⁴ Edwards and Skinner, *Sport Empire*, p. 43.

⁸⁵ For the Swedish development, see: Svensson, D. (2014). “Changing tracks? The battle between natural and scientific training in Swedish cross-country skiing, 1948-1972”, in *Sport, history and society*, vol. 33, pp. 12-41. The international development, especially regarding high-altitude training, is discussed in detail in: Svensson, D. and Sörlin, S. (2015). “Science, Sport et Environnement : le développement des techniques d’entraînement en altitude depuis 1945”, in Quin, Grégory and Bohuon, Anaïs (eds.), *Les Liaisons Dangereuses de la Médecine et du Sport*. Paris: Éditions Glyphe, pp. 195-214.

⁸⁶ Oldenziel, Ruth & Zachmann, Karin. (eds.) (2009). *Cold War kitchen: Americanization, technology, and European users*. Cambridge, Mass.: MIT Press. Albert de la Bruhèze, Adri A. and Oldenziel, Ruth (eds.) (2009).

training was that the written knowledge of scientists was hard to translate into practical use. As there were few professional coaches available, no one could mediate the scientific results to the practitioners of skiing. As cross-country skiing became increasingly sportified, and educated coaches became available as mediators in national teams and in upper secondary ski schools, scientization became more widespread. The role of mediators in the dissemination of scientific or and/or expert knowledge is discussed in depth in Ruth Oldenziel's research. The history of how scientists and other (self-proclaimed) experts domesticated new technology and knowledge about cooking shows the importance of mediators to translate the knowledge to the practical reality of the kitchen. It also demonstrates the importance of transfer in the other direction – from local and individual (kitchens, or in the case of this dissertation, ski tracks and skiers) to global and universal (scientists, policy-makers, experts). The problem with the early attempts to make cross-country skiing more scientific was that there were no mediators who could bring scientific training knowledge to the *mediation junction*, as Ruth Oldenziel has labelled the kitchen and other places and contexts where new knowledge and technology is negotiated.⁸⁷ In the case of skiing, training camps and later specialized high school-level educations served as something similar, a place where different knowledge traditions could meet and be negotiated. However, since the gap between physiologists and practitioners was so wide, the positions were locked and no real mediations or negotiations took place. It was not until the role of mediators (professional coaches) grew in the 1970s that a *mediation junction* could really be seen in cross-country skiing.

Finally, Sverker Sörlin's theory of *articulation of territory* is also important in some of the articles for understanding the process of how certain landscapes have come to be understood as genuine places for training. Sörlin's idea, elaborated in his 1999 article "The articulation of territory: landscape and the constitution of regional and national identity", suggests that landscapes are understood in particular ways due to social processes, often conscious attempts to frame certain places in certain ways. Articulation of territory is "a process of differentiating one area from another, establishing communities of affection and memory".⁸⁸ In the case of cross-country skiing, such places have played an important role in the history of training. Vålådalen, the Vasalopp Arena and other iconic landscapes of skiing have been integral in the creation of a community of memory among skiers, in which these landscapes are part of the explanation of success. But the articulation theory could also be used on the places of science, such as the test labs at The Swedish School of Sport and Health Sciences or Bosön (home of The Swedish Sports Confederation) in Stockholm, as these places have also, through accounts by scientists and visiting athletes, been articulated as important places for sports and for Sweden as a nation. The *articulation of territory* suitable for skiing and running has deeply impacted the ideas about where training should be done in Sweden, and is still alive and well in the planning of urban and suburban landscapes for running and recreation.⁸⁹ The role of territory and landscapes is more closely discussed in the articles "Science, sport and environment: the development of high-altitude training methods after 1945" and "I fäders spår". Additional theories are used and further discussed in the respective articles, while the overarching theories of sportification and rationalization are discussed in detail in the following sections.

Manufacturing technology, manufacturing consumers: the making of Dutch consumer society. Amsterdam: Aksant.

⁸⁷ Oldenziel and Zachmann, *Cold War Kitchen: Americanization, technology, and European users.* See also: Alberts, Gerard and Oldenziel, Ruth (2014). *Hacking Europe: From Computer Cultures to Demoscenes.* London: Springer, p. 6-7.

⁸⁸ Sörlin, Sverker (1999). "The articulation of territory: landscape and the constitution of regional and national identity", in *Norsk Geografisk Tidsskrift – Norwegian Journal of Geography*, 53:2-3, p. 108-109.

⁸⁹ Qviström, "The nature of running: On embedded landscape ideals in leisure planning".

Sportification, rationalization and the development of *rational training*

There is a vast literature on how sports develop and how certain traits tend to be more and more emphasized over time. The theory of sportification (or sometimes sportization) characterizes the development of sports with certain key factors such as rationalization, standardization, professionalization and equalization. The core of the theory is that all sports develop in similar, predictable ways, becoming more rational, systematic, organized, and professional.⁹⁰ Historians are in agreement that there has been a movement from rather spontaneous, loosely organized games and play towards modern sports, and that this process has occurred in parallel with the modernization, rationalization and industrialization of society.

However, it has not stopped there. Today we see the emergence of sports where practitioners' physical movements are very limited, and where different kinds of movements play an important role. Computer games have gone from being a leisure activity for children and teenagers, to being a competitive activity, "e-sports", with international competitions and professional players.⁹¹ At KTH Royal Institute of Technology and many other universities (e.g. Aalto University in Finland and University of Massachusetts Boston in the U.S.) there are courses and communities for competitive programming, something that might be another sign of the sportification of advanced IT and computer skills.⁹² This reflects the importance of computers and IT in society today, while the emergence of cross-country skiing reflected the values and skills admired in communities of the early 20th century (not that these values are not admired today). There are also economic aspects of this – our society has a demand for talented programmers while in the 1950s workers with high endurance were still necessary within forestry.

In cross-country skiing, signs of sportification are easy to see. The specialization of skiers today is, for example, much higher than it was in the mid-1900s, when it was still common for a skier to be competitive in all distances. Standardization refers to structured, reproducible competitions (like defined distances), and common design and use of equipment. Rationalization refers to the development of systematic, goal-oriented and preferably scientific training and the strive towards using a more rational technique. Is this then a natural law, which no sport can avoid? Given current developments in areas that lack the traditional characteristics of established sports (such as e-sport, adventure/lifestyle sports like snowboard or skateboard) sportification theory seems to be a relevant tool.

When applied to the case of cross-country skiing and endurance training in Sweden, the rise of scientific interest coincides with the perceived need for a more productive, well-trained population to

⁹⁰ E.g. Yttergren, *Täflan är lifvet*, p. 21-22. Guttman, *From Ritual to Records*, p. 54-55. Goksöyr, *Sivilisering, Modernisering, Sportifisering*.

⁹¹ Rambusch, Jana, Jakobsson, Peter and Pargman, Daniel (2007). "Exploring E-sports: A case study of game play in Counter-strike", in *Proceedings of Situated Play: Digital Games Research Association (DiGRA) 2007 Conference*, Tokyo, Japan. Jonasson, Kalle and Thiborg, Jesper (2010). "Electronic sport and its impact on future sport", in *Sport in Society*, 13:2, pp. 287-299. Taylor, T.L. (2012). *Raising the stakes: E-sports and the professionalization of gaming*. Cambridge MA: MIT Press. Hutchins, Brett (2008). "Signs of meta-change in second modernity: the growth of e-sport and the World Cyber Games", in *New Media & Society*, 10:6, pp. 851-869.

⁹² KTH Royal Institute of Technology, "Tävlingsprogrammering", <<http://www.csc.kth.se/contest/>>. Aalto University, "Competitive programming", <http://cs.aalto.fi/en/studies/competitive_programming/>. University of Massachusetts Boston, "Competitive programming". <https://www.umb.edu/academics/course_catalog/course_info/ugrd_CS_2016%20Spring_411>.

sustain the ambitious Swedish welfare state.⁹³ The qualities deemed important at the time (e.g. fitness, stamina) fit well together with the endurance sports in which the physiologists invested time. Early scientific interest did not regard sports in a particularly positive light, but was rather concerned with potential hazards of physical training, such as heart disease or “abnormal” musculature.⁹⁴ This kind of critique was, at least in Sweden, often voiced by orthopedists and doctors who favored Ling gymnastics over sports.⁹⁵ This attitude later changed into a certain interest in sports as an interesting object to study.

The qualities of the athletes (endurance, strength etc.) became valued traits that could benefit the population. The negative and paternalistic attitudes towards athletes and sports lingered in some areas, especially regarding female athletes. They were questioned by male doctors, scientists, journalists and others who argued that women should not participate in certain activities that threatened their health, reproductive organs or beauty.

Female athletes in different sports had to suffer such prejudice long after the introduction of *rational training*.

The first serious women’s football teams in Sweden were met with such arguments in the late 1960s, as were female ski jumpers as late as in the early 21st century.⁹⁶

Scientists interested in sports were, at an early stage, ambivalent over its usefulness. However, with the professionalization of sports and the emergence of a growing sports economy, there is now science that focuses on the benefits of sport itself as well as in preventing injuries and maximizing results. Similarly, science has hitherto showed concern over the potential dangers of playing computer games. We now see a shift in this aspect, with some attention being given to e-sports as an interesting field of study.⁹⁷ How long will it take for physiologists, psychologists and other practitioners of scientific expertise to do work on finding methods to improve gamers’ performance? And, perhaps more importantly, finding methods to encourage and develop the skills (speed in action and decision-making etc.) of elite gamers in broader groups of the population. Not because everyone should become an elite gamer, but because a society underpinned by computer technology has obvious interests in developing people who excel in these skills.

An epistemological difference between *natural training* and *rational training* is the level of universality. Where natural training was built on individuality (of both landscapes and athletes), rational training had universal claims. In his 1948 handbook for skiers, Gösta Olander points out that

⁹³ Svensson, “How Much Sport is there in Sport Physiology”.

⁹⁴ E.g. Henschen, Salomon E. (1898). ”Om Skidlöpning och Skidtäfling ur medicinsk synpunkt”, in *Uppsala Universitets årsskrift 1897*. Uppsala: Uppsala Universitet. Dahlstedt, Helge (1927). *Skididrotten, skolan och ungdomens fysiska fostran*. Malmö.

⁹⁵ Söderberg, Benkt (1998). *Tre perspektiv på idrott och medicinvetenskap, 1900–1930* [Three Perspectives on Sports and Medicinal Science, 1900–1930]. Stockholm: Idrottshistoriska specialseminariet, Historiska Institutionen, Stockholm University.

⁹⁶ E.g.: Svensson, Daniel and Oppenheim, Florence (2015). *Etta på bollen: Historien om Öxabäcks damlag*. Landvetter: Oppenheim. Hjelm, Jonny (2004). *Amasoner på planen: svensk damfotboll 1965-1980*. Umeå: Boréa. Tolvhed, Helena (2015). *På damsidan: femininitet, motstånd och makt i svensk idrott 1920-1990*. Göteborg: Makadam. Nybelius, Marit Stub and Hofmann, Annette R. (eds.) (2015). *License to jump!: a story of women's ski jumping*. Spånga: Beijbom books.

⁹⁷ Rambusch et al., *Exploring E-sports: A case study of game play in Counter-strike*. Jonasson and Thiborg, “Electronic sport and its impact on future sport”. Taylor, *Raising the stakes: E-sports and the professionalization of gaming*. Thiborg, Jesper (2011). *Att göra (e)sport : om datorspel och sportifiering*. Örebro : Örebro universitet.

while training advice could be beneficial, “what fits one may not suit the other at all”.⁹⁸ He had no ambition of designing a universal training program for all skiers, even if the fact that he agreed to write a book about training shows that he had some ambition to spread his own ideas in the skiing community. Physiologists, on the other hand, made precisely such claims. It is possible to characterize this dichotomy as natural training being based on individualism, while rational training was more of a collectivist effort. Both in Stockholm and at other world-leading research centers such as the Harvard Fatigue Laboratory, the idea was to translate the test results into universal models applicable in a wide range of activities.⁹⁹ Already in 1943, Hohwü-Christensen hoped to contribute to a universal training knowledge based on science, meaning that “various private tricks and superstition would disappear from the athletic arena”.¹⁰⁰ Training was not something that could be trusted to the individual; it was far too important. Not only could the individual base his/her methods on knowledge that was not scientific, they could also keep relevant information to themselves for competitive reasons. Therefore, argued Christensen, there had to be a rational, scientific base for the training that was to be taught in schools, at sport clubs, etcetera. The implicit argument was that only with a rationally trained population, strong and healthy, could an ambitious welfare state be sustained.¹⁰¹ Such was the level of ambition.

This effort from physiologists emerged within a context of rationalization in Swedish society as a whole. The Swedish welfare state project needed its citizens to be healthy and productive, and rational training for the masses fit perfectly into this ambition.¹⁰² Rational training, based on science, connected to a wider program of replacing traditional livelihoods and knowledge with the promises of the modern, industrial and techno-scientific future. If science was only allowed to influence everything, Sweden would be cleaner, richer and win more gold medals. There were efforts to popularize training as well, through the organization and marketing of training for exercisers, school children and others.¹⁰³ Training knowledge should be rational, open and available to all – such was the ambition. This ideology even made it into the planning of specialized urban and suburban landscapes for training, following the well-established tradition of landscape planning in Sweden.¹⁰⁴ Mattias Qviström at the Swedish University of Agricultural Sciences in Alnarp has shown how as these landscapes were based on the recommendations of scientists, and how the ideas about rational training landscapes were combined with the romantic notions of endurance training as something which should be done in natural surroundings, like forests.¹⁰⁵ This echoes of earlier argumentations along the same lines, when 19th century physical education teacher and training ideologist Anton Santesson argued for

⁹⁸ Olander, *Träningsråd för skidåkare*, p. 3.

⁹⁹ Johnson, “They Sweat for Science”: The Harvard Fatigue Laboratory and Self-Experimentation in American Exercise Physiology”, p. 449 et passim.

¹⁰⁰ Hohwü-Christensen, Erik (1943). ”Förslag till ny utbildningsplan för lärare i gymnastik, lek och idrott”, in *Tidskrift i gymnastik*, nr. 10, 1943, p. 178, my translation.

¹⁰¹ Björck, Henrik (2008). *Folkhemsbyggare*. Stockholm: Atlantis, p. 127–33.

¹⁰² De Geer, Hans (1978). Rationaliseringsrörelsen i Sverige: effektivitetssidéer och socialt ansvar under mellankrigstiden [The Rationalization Movement in Sweden: Efficiency Programs and Social Responsibility in the Interwar Years]. Stockholm: SNS, p. 317–318. Hirdman, *Att lägga livet till rätta*, 176–87. See also: Lundquist Wanneberg, *Kroppens medborgarfostran*. Jonsson, Kjell (1986). ”En nybadad renrasig svensk på ett blankskurat furugolv i ett hus utan löss i ett genomsnittligt samhälle där vetenskapsmannen ser till att fabriker tillverkar foträta skor och ingen är så dum att han på fotboll glör: Hjalmar Öhrvalls person-, bostads-, mental- och rashygien såsom samhällsvision”, in *I framtidens tjänst*, 1986, pp. 102-126.

¹⁰³ Bolling, *Sin egen hälsas smed*.

¹⁰⁴ E.g.: Lundin, Per (2008). *Bilsamhället: ideologi, expertis och regelskapande i efterkrigstidens Sverige*. Stockholm: Kungliga tekniska högskolan. Emanuel, Martin (2012). *Trafikslag på undantag: cykeltrafiken i Stockholm 1930-1980*. Stockholm: Kungliga tekniska högskolan.

¹⁰⁵ Qviström, “The nature of running: On embedded landscape ideals in leisure planning”. Qviström, “Landscapes with a heartbeat: tracing a portable landscape for jogging in Sweden (1958–1971)”.

swimming, walking and climbing in natural surroundings as an important complement to the then world-renowned Swedish Ling gymnastics. He even claimed, contrary to many of his contemporaries, that gymnastics should ideally be performed outdoors.¹⁰⁶

To summarize, most sports rely on natural training in the early stages of development. Swimmers used to swim in lakes, skiers used to ski in the forest, rowers used to row in lakes and rivers, and so on. Then, with the sportification and development of rules, regulations, governance and specialization, training becomes increasingly specialized and influenced by science. This is a vital aspect of the sportification theory. I would argue that all sports have their *natural training* methods that are gradually (but not entirely) adapted to and affected by scientific standards. This does not mean that every aspect of traditional, natural training is abandoned. Swimmers still swim, runners still run, and rowers still row but they do so as a complement to other forms of training that is much more specialized. For example, training sessions aimed at a specific muscle, function or technique. This development is obvious in most sports, but there are also “back to nature” arguments being voiced across the world, especially regarding barefoot running and the increasing popularity of trail running.¹⁰⁷

Most of the discussion above focused on the Swedish development. Therefore, it is appropriate to devote some time to compare this with the international scene. Was the early scientization of training methods a unique Swedish endeavor, or was there similar efforts from scientists and athletic federations in other countries? When it comes to cross-country skiing, a comparison with Norway is hard to avoid. There, scientific training ideology was more controversial than in Sweden. Some of the scientific tests on skiers done in Sweden already in the 1950s were not done in Norway until the 1970s.¹⁰⁸ Skiing in Norway seems to be even more associated with the nation, nature and history than in Sweden.¹⁰⁹ Even if there were some efforts to introduce scientific training methods in Norway as well, the resistance towards such efforts was much stronger. Or rather, the experiential methods were held in higher esteem.¹¹⁰ The Swedish Ski Association relied heavily on physiology, while their Norwegian counterparts sought other ways. A similar difference can be noted between France and Germany, where Germany (like Sweden) has played a massive part in the scientization of training through the work of scientists and coaches (e.g. Herbert Reindell, Woldemar Gerschler).¹¹¹ On the other hand, coaches in France (like in Norway) have historically been more skeptical towards scientific training theories. Michel Jazy and Michel Bernard and some of the other great French middle- and long-distance runners trained in Vålådalen with Gösta Olander, and the French rejected

¹⁰⁶ Santesson, Anton B. (1880). *Ur naturen och samhället*. Stockholm: Albert Bonniers förlag, p. 128. Santesson, b. 1825, d 1892, was educated at GCI.

¹⁰⁷ E.g. Bajic, Blaz, (2014). “Running as nature intended: barefoot running as enskillment and away of becoming”, in *Anthropological Notebooks*, 20 (2), pp. 5–26. McDougall, *Born to run: the hidden tribe, the ultra-runners, and the greatest race the world have ever seen*.

¹⁰⁸ Brå, Oddvar, interviewed 2014-03-11 in Trondheim.

¹⁰⁹ Sörlin, *Kroppens geni: Marit, Petter och skidåkning som lidelse*. Sörlin, Sverker (2011). ”En nasjon krysser sitt spor: Konger, helgener og ’banal nasjonalisme’ i den evige snøens rike”, in *Samtiden*, 122(2011):1, pp.66-83.

¹¹⁰ Sandbakk and Tønnesen, *Den norske langrennsboka*.

¹¹¹ Yttergren, *Träna är livet*, p. 132. Yttergren, Leif (2015). “The Professionalisation and scientification of athletics training in Sweden 1910-1957: Two examples: Ernie Hjertberg and Gösse Holmer”, in *Stadion: Internationale Zeitschrift für Geschichte des Sports*, vol. 40 (2014), no. 1, pp. 57-71. Reindell, Herbert et al. (1962). *Das Intervalltraining*. München.

the German mechanical, scientific training.¹¹² To this day, Olander is held in high esteem in France and has received awards for his involvement in training French athletes.

It is clear that the ideological differences between scientific *rational training* and experiential *natural training* were not limited to Sweden. There were international examples of similar ideas, at the very top level of elite sports. The race for the first sub four-minute mile (famously achieved by Great Britain's Roger Bannister in 1954) was not only fought by the three world-leading runners at the time; Bannister, John Landy (Australia) and Wes Santee (USA), but also between the different training ideologies represented by Bannister's advisor/coach Franz Stampfl and Landy's coach Percy Cerutti.¹¹³ Stampfl was an admirer of scientific methods, while Cerutti held views similar to Gösta Olander when it came to the importance of nature and joyful training. An interesting aspect of this is that Cerutti, the proponent of *natural training*, was inspired by Gösse Holmér's "speed play" or "fartlek" while Olander and Holmér were bitter opponents in Sweden at the time.¹¹⁴ In the 1960s, while Swedish physiologists had gained an international reputation for their work with sport-related physiology, Soviet scientists focused on a scientific model of periodization of training which would prove to be highly influential in endurance sports.¹¹⁵ Contributions to the sportification process of training came from many different countries and from political systems that organized both sport and science in very different ways.

The differences in contributions and receptions illustrate how local, regional and national context can influence training and the role of scientific knowledge in it. Previous research has identified national differences regarding science,¹¹⁶ which can be applied for training as well. Even if the theoretical knowledge base is similar, there are differences in practice and outcome that cannot be explained by physiology. Training cannot be reduced to numbers only; it is also cultural, for better or worse depending on who you ask.

One example of this is the mediation of scientific training knowledge to the athletes, and the identification of which athletes to invest the most in. Sweden did this primarily through the introduction of *skidgymnasium*, national sports upper secondary schools for would-be elite athletes. Cross-country skiing was among the first few sports to participate in this process with the start of the school in Järpen (close to Åre) in 1971.¹¹⁷ These educations have proven to be very successful in terms of the delivery of elite athletes, but compared to other states, such as East Germany, the Swedish education program was a minor effort. In East Germany, state-organized doping, talent identification and athletic education contributed to the country's unprecedented success in terms of Olympic medals per capita.¹¹⁸ The science available was similar, but the mediation of it to the athletes was organized in different ways due to political and cultural differences. Where scientific methods in Sweden were

¹¹² Roger, Anne (2005). "Das Training der französischen Mittelstreckler (1945-1970). Auf der Suche nach einer französischen Methode", in Jürgen Buschmann & Stephan Wassong (eds.), *Langlauf durch die olympische Geschichte. Festschrift Karl Lennartz*. Köln: Carl-und-Liselott-Diem-Archiv, pp. 405-429.

¹¹³ Bourne, *Fast science: a history of training theory and methods for elite runners through 1975*, p. 200-203, 222-223.

¹¹⁴ More about Olander's training ideology and the battle between Olander and Holmér is found in: Svensson, "Changing tracks", included in this dissertation.

¹¹⁵ Matveyev, L.P. (1965). *Periodization of Sports Training*. Moscow: Fiskultura i Sport.

¹¹⁶ Jamison, Andrew (1982). *National Components of Scientific Knowledge. A Contribution to the Social Theory of Science*. Lund: Research Policy Institute.

¹¹⁷ Uebel, Maja (2006). *Nya perspektiv på riksidrottsgymnasierna - Vad flickor och pojkar värdesätter i RIG-verksamheten*. Stockholm: Swedish Sports Confederation, p. 10-11.

¹¹⁸ Dennis, Mike and Grix, Jonathan (2012). *Sport under communism: behind the East German 'miracle'*. Basingstoke: Palgrave Macmillan, p. 56-57. See also: Skjeldal, Gudmund (2014). *Nestbest: Ei personlig idéhistorie om bronse, sølv og gull*. Oslo: Cappelen Damm.

gradually introduced and athletes had the power to at least partly reject these new methods, countries like East Germany were more authoritarian and their scientization of sport (talent identification, training, coach education, even doping) was more far-reaching.¹¹⁹

Another aspect where the practical application of sport-related science led to different results is training for the broader public. While Swedish physiologists argued for rational training based in specialized, constructed landscapes like flood-lit tracks, American physiologists and doctors were an important force behind the introduction of jogging in the US (and subsequently in many parts of the world) in the 1960s.¹²⁰ Jogging, as opposed to the Swedish version of fitness running, was not bound to any particular landscape but could be done on the sidewalks of New York as well as in the forests of Maine. Jogging had another cultural base than Nordic cross-country skiing and fitness running, but the scientific base was similar even if the productive aspects were in focus for Swedish physiologists while their American colleagues focused more on jogging as a counter-measure to sedentariness.

Continuing with running in its different forms, it is clear that there have been continuous innovation in training methods since at least the 1920s when Paavo Nurmi experimented with interval-like training at high intensity.¹²¹ In the 1930s, this was further developed through innovations like “speed games” and interval training, the systematization of high-intensity runs developed by the Germans Herbert Reindell and Woldemar Gerschler.¹²²

Gender in rational and natural training

Sports, like other professions, can be, and often are, gender coded.¹²³ If the concept of gender coding is applied to cross-country skiing, the latter is undoubtedly coded as male. Most sports were at the time coded as male, and some sports continued to be long after women’s cross-country skiing was included in the Olympic Winter Games in Oslo in 1952.¹²⁴ For cross-country skiing, this had partly to do with its relation to forestry. Natural training, as outlined by Gösta Olander in the 1940s, relied heavily on such traditionally male endeavors as forestry and hunting, and focused implicitly on the training of men through movement in natural surroundings. All the athletes named in Olander’s 1948 training manual were male, and there is no mention of the possibility of female skiers.¹²⁵ While I have not primarily been studying cross-country skiing from a gender perspective, nor as a researcher of masculinity in sports, there are certain aspects of the gendered skier that have particular importance for the construction of training ideology. For example, physiologists at GCI were concerned with the amount of training suitable for male and female skiers, respectively.¹²⁶ The role of gender and the

¹¹⁹ Hoberman, *Mortal Engines*, p. 222-223.

¹²⁰ Latham, Alan (2015). “The history of a habit: jogging as a palliative to sedentariness in 1960s America”, in *Cultural Geographies*, vol. 22(1), pp. 103-126.

¹²¹ Bourne, *Fast science: a history of training theory and methods for elite runners through 1975*, p. 157-159.

¹²² Bourne, *Fast science: a history of training theory and methods for elite runners through 1975*, p. 171-172, 175-176.

¹²³ Sommestad, Lena (1992). *Från mejerska till mejerist: en studie av mejeriyrkets maskuliniseringsprocess*. Lund: Arkiv.

¹²⁴ As an example, women’s ski jumping was not included in the Olympic program until Sochi 2014: Nybelius and Hofmann, *License to jump!: a story of women's ski jumping*.

¹²⁵ Olander, *Träningsråd för skidåkare*.

¹²⁶ Larsson, Håkan (2011). “Sport physiology research and governing gender in sport—a power-knowledge relation?”, in *Sport, Education and Society*.

differences in training between male and female skiers is not a primary issue in this dissertation, but aspects of gender are discussed in several of the articles. It is worth noting that most of the skiers and almost all of the scientists and leading officials within the Swedish Ski Association were men. Irma Åstrand was a leading physiologist at GCI, but she did not primarily work with the sports-related projects even though she was involved in the design of fitness tests later used to test athletes. The direct interaction with skiers, both male and female, was primarily handled by male physiologists. Inga Löwdin, herself a good cross-country skier, held leading positions within the Swedish Ski Association during my period of study but, from what I have found, her influence on practical training was limited. Male dominance can be found in all aspects (scientific, organizational and practical) of cross-country skiing in Sweden from 1930-1980. In this regard, skiing resembles other activities such as ice hockey, football and hunting, all strongly gender coded.¹²⁷ There are, and have been for a long time, women who excel in these activities, but their efforts are made invisible through the discursive formation of these activities as male. Similar processes of masculinity formation have been analyzed in older regimes of training such as Ling gymnastics.¹²⁸

Despite the long tradition of male skiing (in hunting, forestry, and transport), female skiers participated in international competitions much earlier than in many other sports (not least football), and a quick scan of the commentary fields of any online newspaper indicates that female skiers are still less controversial than female footballers. While female skiers were part of national team competitions and training camps already in the 1940s, it would take until the late 1960s before the first Swedish women's football series was organized, by pioneering Öxabäcks IF.¹²⁹ There are records of female participation in international ski events already in the late 19th century.¹³⁰ Why was cross-country skiing, a sport traditionally gender coded as male, more open to women than other sports (e.g. football, hockey, ski jumping)? One possible answer could be that the physiologists at GIH in Stockholm advocated endurance training as suitable for women, albeit in smaller doses than for men. GIH physiologists, starting with the first physiology professor Eric Hohwü-Christensen, have argued for women's participation in sports. However, they did so using arguments that declared some sports more suitable for women, and others less suitable. As Håkan Larsson at GIH has argued: "Sports physiologists have consistently acted as champions of women's sport participation throughout this period, although their discourse might be viewed as restrictive and even misogynist in hindsight".¹³¹ Physiologists like Hohwü-Christensen and Per-Olof Åstrand claimed that women could very well participate in sports, even endurance sports, without harm. Skiing was explicitly mentioned as a suitable sport among others, while football was seen as less suitable.¹³² This was a first step in establishing cross-country skiing as a sport open to women as well.

¹²⁷ MacKenzie, John M. (1988). *The empire of nature: hunting conservation and British Imperialism*. Manchester: Manchester University Press. Wulff, Helena (2009). *Dancing at the crossroads: memory and mobility in Ireland*. New York: Berghahn Books. Lagergren, Lars (2003). "Elitutbildningar inom kultur- och upplevelseindustrin", in Sörlin, Sverker (ed.) *Kulturen i kunskapssamhället – Om kultursektorns tillväxt och kulturpolitikens utmaningar*. Nora: Nya Doxa, pp. 59–76. Fundberg, Jesper (2003). *Kom igen, gubbar! Om pojkfotboll och maskuliniteter*. Stockholm: Carlssons.

¹²⁸ Ljunggren, Jens (2000). "The masculine road through modernity: Ling gymnastics and male socialisation in nineteenth-century Sweden", in *Making European masculinities*, 2000, pp. 86-111.

¹²⁹ Svensson and Oppenheim, *Etta på bollen: Historien om Öxabäcks damlag*. Hjelm, *Amasoner på planen: svensk damfotboll 1965-1980*.

¹³⁰ Löwdin, Inga (1994). "Tillbakablick på skidornas damlängdlöpning som tävlings sport 1880-1965", in *Idrott, historia och samhälle*, 1994.

¹³¹ Larsson, "Sport physiology research and governing gender in sport—a power-knowledge relation?", p. 13.

¹³² Larsson, "Sport physiology research and governing gender in sport—a power-knowledge relation?", p. 7, 9.

When Åstrand and colleagues entered into collaboration with the Swedish Ski Association, they tested both male and female skiers. But there was an emphasis on the men, and some of the female skiers felt less prioritized at times. Britt Strandberg, a member of the national team during the 1960s, states that neither physiologists nor Gösta Olander paid much attention to the female skiers.¹³³ The male skiers were the priority.

There was also at times a frustration within the Swedish Ski Association regarding the level of training and fitness among female skiers in comparison to their male colleagues.¹³⁴ The male skier was the norm, and the female skier was measured against how the men trained, how many hours they spent on training and how well they performed on certain physiological tests. The skier was gender coded as male. There were, to use a vocabulary that was not available at the time, gender boundaries that prevented female skiers from constructing their own identity as athletes. Gender construction in sports, and ways to transcend and transform such boundaries, has been discussed in a number of books and articles in recent years. A result from this research is that physical cultures have gender boundaries, so that certain sports have, historically, been articulated as a suitable activity for men, women or both.¹³⁵

But athletes are not just victims of structural discrimination or gendered discourse – they have a transformative power. Athletes can transform or transgress gender boundaries.¹³⁶ In skiing, such transformative work was done by Toini Gustafsson-Rönnlund, Britt Strandberg, Barbro Martinsson and other women on the Swedish national cross-country skiing team. Their seriousness, will to improve training and other preparations, and high level of performance in international competitions was crucial for the establishment of women's cross-country skiing in Sweden. Despite their efforts and the relative success of female skiers in the 1960s, it is quite telling that the most iconic ski race in Sweden, Vasaloppet, did not allow female participants until 1981 (partly due to regulations of FIS which did not allow female participants in races longer than 25 kilometers).¹³⁷

Sports are sometimes highlighted in public debate for issues of discrimination. However, it has also been argued that sports can function as an arena for recognition of rights, not least relating to gender.¹³⁸ In the case of ski jumping, a sport coming out of the same tradition as cross-country skiing, women were excluded from international competition until the 21st century. Now they are allowed to compete in World Championships and Olympic Winter Games, but to have full recognition would include not only the right to participate in competitions but also to have a say in the setup of training. Such struggles over the power of definition, regimentation and training have been important in other sports, in relation to female athletes and especially in relation to the discursive formation of sports.¹³⁹

¹³³ Strandberg, Britt, phone interview 2015-01-13.

¹³⁴ E.g. Swedish Ski Association (1958). *Styrelseberättelse 1957-58*. Stockholm: Swedish Ski Association, p. 40.

¹³⁵ Gori, Gigliola (ed.) (2008). *Sport and gender matters in western countries: old borders and new challenges*. Sankt Augustin: Academia Verlag. For an example from the Olympic scene, see: Hedenborg, Susanna (2008). "Enkelt fältgrått och amasoner i topp: ryttarolympiaden 1956 analyserad ur genus- och klassperspektiv", in *Idrott, historia och samhälle*, 2008, pp. 69-91.

¹³⁶ Barker-Ruchti, Natalie, Grahn, Karin & Lindgren, Eva-Carin (2015). "Shifting, crossing and transforming gender boundaries in physical cultures", in *Sport in Society: Cultures, Commerce, Media, Politics*. DOI: 10.1080/17430437.2015.1073942.

¹³⁷ Larsson von Garaguly, Joacim (2016). *Vasaloppet - resan från skidtävling och skidlöpare till produkter och kunder: en studie om kommersialisering och professionalisering*. Stockholm: Handelshögskolan. p. 128-129. See also: Marklund, Pelle (2000). *Det stora äventyret: Vasaloppet under 1900-talet*. Västerås: Sportförlaget.

¹³⁸ Andersen, Wivi and Loland, Sigmund (2016). "Jumping for recognition: Women's ski jumping viewed as a struggle for rights", in *Scandinavian Journal of Medicine & Science in Sports*. DOI: 10.1111/sms.12662.

¹³⁹ E.g. Tolvhed, Helena (2008). *Nationen på spel: kropp, kön och svenskhet i populärpressens representationer av olympiska spel 1948-1972*. Umeå: h:ström - Text & kultur. Tolvhed, På damsidan, Hjelm, Amasoner på planen: svensk damfotboll 1965-1980, Nybelius and Hofmann, *License to jump!: a story of women's ski jumping*.

In the case of Swedish cross-country skiing, training was first defined by tradition (a male tradition in which women were not included, based on forestry work and other hard physical work gender coded as male). Then came the rational training model, based on physiological research primarily done by males, on males and for males. It took a great deal of courage and determination for Swedish female skiers to demand a say in their own training. Recognition of their rights was not granted, but fought for. And they are still fought for, not least in the specialized educations for elite skiers where reports about sexual harassment and misogynist attitudes have highlighted the need for continuous discussion and examination of the culture of elite sports.¹⁴⁰ Moreover, this applies not just to elite sports but sports in general. Elite sports are hierarchical, and the focus on the elite level in the history of sports has been highlighted as a potential problem that can undermine attempts at criticism.¹⁴¹ It is not always among the elite that the transformation of gender boundaries occurs, even if it is most visible and public there.

¹⁴⁰ Sörlin, *Kroppens geni*, p. 161. See also: Norrländska Socialdemokraten, official website, "Sexskandal skakar skidgymnasiet". Retrieved 2016-07-18 at: <<http://www.nsd.se/nyheter/sexskandal-skakar-skidgymnasiet-7496395.aspx>>.

¹⁴¹ Bandy, Susan J. (2016). "Gender and the 'cultural turn' in the study of sport and physical cultures", in *Sport in Society*, 19:5, p. 732.



Picture taken at first training camp for skiers in Vålådalen, 1934. From left: Arthur Häggblad, Elis Wiklund, Nils Swärd, Martin Matsbo, Axel Vikström and Gösta Olander.

Photo: Sten Nordenskiöld/Jamtli's photosamlingar.



Training camp in Vålådalen, August 1959. Sune Larsson training with roller-skis, instructed by Mora-Nisse Karlsson.

Photo: Hallings foto/Jamtli's fotosamlingar.



Test on bicycle ergometer, monitored by test leader Beng Saltin (to the left of the bicycle).

Photo: Hallings foto/Jamtli's fotosamlingar.



Per-Olof Åstrand (to the right) monitoring a test on bicycle ergometer.

Photo: Hallings foto/Jamtli's fotosamlingar.



In Vålådalen, 1958. From left SSF chairman Sigge Bergman, skier Martin Lundström och physiologist Per-Olof Åstrand.

Photo: Hallings foto/Jamtlis fotosamlingar.



Skiers training indoors in Vålådalen, 1961.

Photo: Hallings foto/Jamtlis fotosamlingar.



The candidates for the Olympic Games 1964 training in Vålådalen, August 1963. From left: Barbro Martinsson, Toini Gustafsson, Britt Strandberg, Gunnel Norman och Majlis Andersson.

Photo: Hallings foto/Jamtli's fotosamlingar.



Running in the forest as training for FIS World Championships 1970. From left: Jan Halvarsson, Lill-Järven Lennart Larsson, Åke Wingskog, physiologist Sune Wehlin, and Bengt Herman Nilsson.

Photo: unknown/Jamtlis fotosamlingar.

Introducing the articles

This compilation thesis contains five articles (of which one is featured in two versions, in French and in English). The first three deal directly with the construction of training methods in Swedish cross-country skiing, from the perspectives of science, the Swedish Ski Association, and the skiers. The last two articles take a somewhat different approach. The article on high-altitude training seeks to analyze the relations between science and landscape, through the high-altitude issue. The last article looks closer at the less scientific notions of sport landscapes, as genuine places for skiing and running, and as cultural heritage. My main objective has been to identify the most important ideas and actors involved in the transformation of training and landscapes of training from individual, experiential and local, to universal and scientific, and the ideas behind this transformation. I will now make a brief presentation of the articles and their main results.

“How Much Sport is there in Sport Physiology? Practice and Ideas in the Stockholm School of Physiology at GCI, 1941–1969”

The physiology department at what was then called The Royal Central Institute of Gymnastics (GCI, now re-named The Swedish School of Sport and Health Sciences, GIH) plays an important role in the history of cross-country skiing. They were the first in Sweden to take a scientific approach to training, and they wanted to influence the training of the entire population, not just elite athletes. The ambition to rationalize training was a step away from the earlier model of physical exercise in Sweden, the Ling gymnastics system, which put more emphasis on aesthetics and tradition.¹⁴² The physiology research at GCI was never primarily focused on sports, but has made significant contributions to sport and exercise physiology. Changing ideas about the human body (from form to motor) during the early twentieth century led to criticism towards the posture-oriented Ling gymnastics. The rationalization movement of the 1930s and onwards also paved the way for a rationalistic physiology research.

GCI recruited Eric Hohwü-Christensen (1904–1996) from Copenhagen for the new position as professor in physiology in 1941, and in doing so made a clear choice to step away from the GCI tradition of Ling gymnastics, towards a more scientific approach to training. The appointment of Christensen was very controversial and there was an agitated debate over this turn towards physiology at the flagship of Swedish physical culture and education. With the recruitment, Swedish physiology related to Danish (University of Copenhagen) and American (Harvard Fatigue Lab) physiology, which had already begun some testing of athletes as part of their research. Christensen’s arrival signaled a new way of understanding the human body, as a motor that could be tuned and improved for better performance. It was a clear step away from the earlier ideology of physical education and training, which was based on Ling gymnastics with its view of the body as an aesthetic form or model. Christensen built his research program on the ideas of the Copenhagen School, focusing on basic research, bodily limits and rationalization of exercise. The majority of research at GCI focused on basic physiology, and the main goal was to rationalize the exercise of the entire population, which was in line with the ambitions of the emerging Swedish welfare state. But applications in elite sports became a claim to fame for GCI through names such as Per-Olof Åstrand and Bengt Saltin. This article shows how the research program during Christensen’s professorship, 1941–1969, evolved around issues of the limitations of human physical performance and how these limits could be moved. Such research questions were a perfect match for elite sports, and it did not take long until contacts

¹⁴² Ljunggren, Jens (1999). *Kroppens bildning: Linggymnastikens manlighetsprojekt 1790-1914*. Eslöv: Symposion.

(initiated by the Secretary of the Swedish Ski Association, and former GCI student, Sigge Bergman) were up and running. In retrospect, the physiology department at GCI has been labeled a sports science department, but to their own understanding they did basic research that was to be applied in many areas of society, not just sports.

“Changing tracks? The battle between natural and scientific training in Swedish cross-country skiing, 1948-1972”

Until the 1950s, Swedish cross-country skiers relied on natural training. But in the wake of failure at the 1952 Winter Olympics in Oslo, the Swedish Ski Association initiated a scientization of training. They sought aid from physiologists to rationalize the training of elite skiers. But the advocates of *natural training* resisted this new, scientific model. A battle was fought between the two sides, and a number of different power strategies were used by the skiing federation and the physiologists to promote scientific training. In this article, the battle between different training regimes is analyzed using theories of power and sportification.

The article also discusses the discourse of training, and who has power over it. Clearly skiers in the 1970s meant something totally different when they spoke of rationality than did their colleagues in the 1940s. In that way, the Swedish Ski Association had succeeded in their ambition to bring science into training. But it was a slow and meandering process that more than anything illustrates the importance of professional coaches to make any practical difference. As the coaching role was developed and professionalized (and backed by a more efficient organization) the coaches took hold of a competence that was previously the prerogative of skiers. The early professionalization (in the 1950s) of coaches in athletics shows the importance of well-educated and professional coaches in order to implement science in practice. This case study shows that in order for training to be rationalized, other criteria of sportification (like organization, equality, regimentation and specialization) have to already be in place. In skiing, the lack of specialized, professional coaches slowed down the rationalization of training significantly, despite the ambition of the Swedish Ski Association to be avant-garde. Even if there were (and are) still many elements of natural training that are important for elite athletes, the skiers were not to be entrusted with realizing their potential. Ensuring the productive development of talent was a job for scientists and professionals, echoing what in Foucauldian terms would be called “bio-power”.¹⁴³ The sportification process has also meant a power shift, from practitioners to the Swedish Ski Association, the physiologists and the coaches.

The article concludes that the shift towards rational training during the period 1948-1972 was part of a larger rationalization of Swedish society. And the relative slowness of implementation was due to a lack of professionalization (of coaches). When professionalization occurred, it was amongst coaches who were influenced by the ideals of scientific training. Rationalization of training should therefore be seen as one of the later stages of sportification.

“Technologies of sportification – Practice, Theory and Co-Production of Training Knowledge in Cross-Country Skiing Since the 1950s”

Elite endurance athletes of today use specialized, scientific training methods and the increasing role of science in sports is undeniable if analyzed in a longer perspective. This is especially true for cross-

¹⁴³ Foucault, *The Will to Knowledge part 1: The History of Sexuality*, p. 140-141.

country skiing, a sport that was an early adopter of scientific training knowledge. But how and when did scientists and educated coaches gain power? This paper analyzes how physiologists and skiers interacted in the transformation of training methods, focusing on the *technologies of sportification* that were used. Examples of such technologies are scientific testing, training logs, training camps, professional coaches and training manuals. The article focuses on the use of these technologies in the meeting between scientists and skiers in the Swedish national cross-country skiing team. Results show that while *technologies of sportification* could not ensure a rapid rationalization of training methods, these technologies over time became standard features in the training and sportification of skiing. The article has the dual purpose of showing how the scientization of Swedish cross-country skiing was accelerated through the use of certain technologies, and how the theory of sportification could benefit from adding *technologies of sportification* to its repertoire. *Technologies of sportification* can be framed as opposing what Michel Foucault labelled “technologies of the self”, i.e. strategies or practices used by the individual (in this case a skier) to change the self.¹⁴⁴ In some cases, technologies of self and of sportification coincided. For example, some skiers used training logs as a technology of the self to design and evaluate their training, while the physiologists wanted to use the same technology to control training.

Technologies of sportification were introduced by the Swedish Ski Association to support their ambition for a scientization of training and other preparations for elite athletes. However, some of these technologies were used by the skiers in ways the Swedish Ski Association had never intended. The training camp became a way to discuss and spread experiential training methods as much as scientific ones. Training logs were kept secret by the skiers and not, as intended, handed over to the physiologists for analysis. This type of reception of technology and science relates to mediation and dissemination research (i.e. the research conducted by Ruth Oldenziel).¹⁴⁵ In the case of cross-country skiing, *technologies of sportification* did not have an immediate effect. Most skiers continued to rely on their experiential, personal knowledge regarding training. But the technologies of sportification that were introduced gradually became normalized for new generations of skiers. By the late 1970s, training logs, training camps, scientific testing and training manuals built on scientific knowledge had become standard features of elite cross-country skiing and also of other outdoor endurance sports such as long-distance running and orienteering. These numerical technologies fit well with the concept of rationality advocated by physiologists. The rationalization of training in 20th century physiology depended on ideas of de-individualization and universalization, while training methods (and even physiology) today is more individualized.

“Science, Sport et Environnement: le développement des techniques d’entraînement en altitude depuis 1945” (English title: “Science, sport and environment: the development of high-altitude training methods after 1945”)

This book chapter, published in French translation in the edited volume *Les Liaisons Dangereuses de la Médecine et du Sport*, was co-authored with Sverker Sörlin. We wrote the chapter together and although it is hard to distinguish exactly who wrote what, my contribution was at least 50 percent of

¹⁴⁴ Martin, Luther H., Gutman, Huck and Hutton, Patrick H. (eds.) (1988). *Technologies of the self: a seminar with Michel Foucault*. Amherst, Univ. of Massachusetts Press, 1988.

¹⁴⁵ Oldenziel & Zachmann, *Cold War kitchen: Americanization, technology, and European users*.

the final result.¹⁴⁶ Here we deal with the history of high-altitude training, and its scientific background. Today, most elite endurance athletes use high-altitude training to some extent. For at least the last 40 years, it has been linked to increased performance. But how was high-altitude training established by scientists as a means of improving performance? And how did the scientific approach to altitude differ from the traditional, natural valuation of mountains as a site for training? High-altitude training was introduced in sports in the post-war period. It was first and most consistently researched by physiologists, financed partly by their universities and partly by other interested parties, such as sport organizations, military interests and civil aviation. Famous centers of physiology research, like GCI in Stockholm and the Harvard Fatigue Laboratory in Boston, devoted both time and resources to the high-altitude issue. During the 1960s, it became a highly contested method, with controversies between scientists, athletes, doctors, sport organizations and coaches. What ideas about altitude and performance were important in this process?

Interestingly, those within sports who rejected the scientific, “machine-like” training methods also often valued the mountains. Famous Swedish coach Gösta Olander is one example. He was the most influential protagonist of the natural training method in Sweden, and his base was in Vålådalen (in Jämtland, near Östersund and Åre). Both Swedish (e.g. Sixten Jernberg, Gunder Hägg) and international athletes (e.g. Michel Jazy and Michel Bernard) came to Vålådalen. The fresh mountain air and scenic surroundings were important as a place for training camps, but scientists later demystified the mountains via scientific explanations about increased oxygen uptake and increasing hemoglobin levels in the blood. It was soon agreed that high-altitude training could be an advantage for endurance athletes, and therefore it needed to be regulated to level the playing field and ensure the continued unpredictability of sports (a factor listed as equalization in sportification theory). The setting of international standards regarding high-altitude training was a problematic process full of conflicts (and those with a soft spot for conspiracy theories might also say that it had political aspects, as the issue received more interest when white runners from low-altitude areas were threatened by the results of runners mainly from high-altitude countries like Kenya and Ethiopia). Swedish physiologists Bengt Saltin and Per-Olof Åstrand were both involved in the high-altitude issue, from the perspective of sport-related physiology.

”I fäderns spår? Längdskidåkningens landskap som kulturarv” (English title: “In the tracks of our fathers? Landscapes of skiing as cultural heritage”)

This article discusses the landscapes of skiing from a heritage and memory perspective. Are there certain landscapes of cross-country skiing that can be seen as a cultural heritage? What constitutes these landscapes and how are they portrayed in tourism and marketing today? Through the analysis of three examples, Hindås, Vålådalen and Vasaloppet, this article investigates how history and landscape is used to market skiing in the area and to attract (skiing) tourism. By looking at the current marketing efforts of Vasaloppet, Vålådalen and Hindås as genuine places for and of skiing, I raise questions about how skiing as cultural heritage is constructed and used for present day purposes. The three above-mentioned cases are also compared with a different one, Landvetter, a place where cross-country skiing does not have an equally rich history. The conclusion is that ideas about landscapes of skiing unite Vasaloppet, Vålådalen and Hindås, even though the efforts and commercial effects may differ greatly. These landscapes of skiing are all deeply embedded in classic Nordic ideas about nature

¹⁴⁶ I stood for the main part of the empirical work and wrote most of the text regarding the sport-related issues of high-altitude, while Sverker Sörlin worked with the contribution of Harvard Fatigue Lab and also contributed to other parts of the text.

and the relation between nature and physical performance. Moving through the landscape through personal, physical effort resonates with Nordic ideals of access to nature through the traditional *Allemansrätten* (Right of public access).¹⁴⁷ Cross-country skiing and fitness running (with its origins as modes of transport) have historically built on these ideas about nature as an arena for physical activity, and the very activity could potentially be seen as a form of consuetude and tradition, claiming the landscape with its paths, trees and mountains for the sake of training.

The role of nature in skiing and running is huge, and even scientifically influenced infrastructures of training like flood-lit tracks for skiing and running carry the legacy of nature as the primary and ideal setting for training.¹⁴⁸ It is also interesting to see what happens with such romantic ideas about nature and training when training is moved indoors, to ski tunnels or treadmills.¹⁴⁹ *Technologies of sportification* are hybridized and flexible, so that training camps are placed at ski tunnels, and treadmills and self-monitoring technologies brought to training camps. Training logs are linked directly to pulse-monitoring devices via web-based tools such as Strava or PolarFlow. Coaches use all of these technologies in their role. Training manuals rely heavily on scientific and technological advances. Another conclusion is that landscapes of skiing (or any sport) are cultural products, and their remains are best understood as a form of cultural heritage. Landscapes of sport are now slowly being articulated as sites of cultural heritage, much resembling the *social articulation* process of other previously neglected landscapes of industry, research, and other activities.¹⁵⁰ This articulation implies a broadening of the cultural heritage, a process that risks being paralleled by a commercialization and devaluation of the increasingly inclusive heritage concept. But there are also more positive aspects. The inclusion of *landscapes of mobility* in the cultural heritage can result in both protection and increased attraction, like in the case of the Vasalopp Arena.

Concluding remarks

History of sports is a fruitful field if we are to understand the developments in 20th century society and the relations between ourselves, our bodies and our landscapes. In the dramatic changes we have seen in our societies over the last century, sport and training have constantly grown in significance – economically, culturally and politically. From the early attempts of sportification of traditional activities to today’s international super-economy of sports, the social and economic significance of sports and training has increased. As we have become ever more sedentary in our homes and workplaces, the number of people who actively pursue countermeasures has multiplied.

While some may dismiss history of sports as a marginal, specialized strand of history, this dissertation, building on a growing body of work in the history of sport, science, medicine, and other sub fields, demonstrates that it can be much more. The dissertation is first and foremost history, and as such it can increase our understanding of how the organization of our lives has changed. But it is also sports history, no less potent than other special areas of history. Rather, sports are a field of study where ideas about bodies, landscapes and health intersect and are represented in ways that invite critical discussion.

¹⁴⁷ Kayser Nielsen, “Movement, Landscape and Sport. Comparative Aspects of Nordic Nationalism between the Wars”, p. 87–89.

¹⁴⁸ Qviström, “The nature of running: On embedded landscape ideals in leisure planning”.

¹⁴⁹ There is not much research on this, but one example is: Reid, Vybarr (2012). “Running Wilde: Landscape, the Body, and the History of the Treadmill”, in *Critical Survey*, vol. 24(3), pp.73-91.

¹⁵⁰ Sörlin, Sverker (1998). “Monument and memory”, in *Worldviews: Global Religions, Culture, and Ecology*, 2(3), pp. 269–279.

This is about body politics in a specific way, namely society as a body of human bodies, a productive unit that was to be trained for better performance. This was important for societies across the political scale, and the Swedish welfare state project was no exception. When physiologists designed rational training models, their primary objective was not to win gold medals but to increase the competitiveness of the nation through the optimization of its workforce. When Mora-Nisse Karlsson talked about rational training in the 1940s, he did not care about such things. Still, he was part of a larger change in body politics where the responsibility of taking care of the individual body could no longer be entrusted to the individual, but was to be aided by science. This was modernization in the making. With the ties of endurance sports to military purposes and nationalist discourses, skiing was perhaps the most potent example of how individual bodies became role models for larger parts of the population. This is still ongoing. When Swedish and Norwegian royalty visit ski competitions it is probably because they enjoy the sport. But there is also an element of national gathering, of inspecting the elite troops of the nation. I have a hard time seeing the Swedish king visit the computer gaming event Dreamhack to applaud the best gamers. Their bodies, as specialized and trained as they may be, do not contribute to the same goals as does a body trimmed by heavy endurance training.

GCI physiology professor Eric Hohwü-Christensen stated already in 1943 that we should “learn to hold on to that of the old which is good – not because it is old, but because it is good”.¹⁵¹ You could also say the same thing with slightly shifted emphasis in these times of fast reassessment and change. We should get rid of that of the old which is bad – not because it is old, but because it is bad. What is worth preserving should not be discarded because of age. There, historical research has an important contribution to make. One of the ambitions of this dissertation is to improve our understanding of how processes of change in sports and training have developed historically, and how the experiences of the past can be used within sports today. For training is not only science, even if the role of sports science has grown continuously since the 1940s. Aspects of natural training are still important, for elite athletes and exercisers alike.

There are also other conclusions to be drawn from the developments in training during the 20th century. Not least on how the desire for knowledge about the body and its performance during physical activity has united different interest groups – physiologists, the military, state planners, sport organizations and industrial leaders. In the process of industrialization, rationalization and modernization during the 20th century, the body became an important tool for maximizing the effectiveness of workers, ensuring the top-level physical endurance of soldiers, promoting healthy habits for citizens in order to avoid unnecessary healthcare costs that could potentially threaten the economic foundation of the welfare state, and winning medals in international sport competitions. While the latter from a socio-economic viewpoint may have been the least important, the athletic body was perhaps the most vital part of the knowledge base for the physiology research that tried to tackle all the issues listed above (compare with present debates on obesity for a similar multi-faceted health issue). The athlete became a tool for research – to further knowledge about how the body could be trained to better performance. Research also became a tool for sports – to get an advantage in the hardening international competition of the 20th century. It is telling that the major physiology centers that have contributed to work physiology – such as the GCI or the Harvard Fatigue Lab – have had a focus on work physiology but have used athletes in their tests.

This is also a history of technology. Training methods can be seen as a form of *low tech*, where techno-scientific innovations are constantly intertwined with tradition, personal experience and

¹⁵¹ Hohwü-Christensen, Erik (1943). ”GCI:s fysiologiska institution”, in *Tidskrift i gymnastik*, nr. 3, 1943., p. 49.

opinions.¹⁵² If Eric Hohwü-Christensen would have seen his progressivist, rationalistic program fulfilled, then all of the non-scientific elements of training would have been gone by now. But that is not how things have worked out. Training is still in many aspects individual, still dependent on local context and landscape. And just as Edgerton argues that the history of technology is written with the wrong focus if we only look at innovations and not the actual use of technology, the history of training is misinterpreted if the progress of physiological research is expected to have an equal impact in actual training methods.¹⁵³ I have tried to show in this dissertation that despite world-leading physiological research, the training of Swedish cross-country skiers changed only slowly, and that it continued to rely on other sources of knowledge (practical, traditional, experiential). In cross-country skiing as well as in other sports and physical cultures, scientific innovations have been used alongside older technologies, traditions and tacit knowledge.

This also has implications for the history of science. Swedish history of science has not primarily looked at what, in analogy to *low tech*, may be labeled “low science”, i.e. science which solves a problem and then cannot be dramatically improved, like a wooden spoon solves some problems in the kitchen and is still the best solution to those problems.¹⁵⁴ The history of research relating to mundane bodily practice has room for increased attention, because it is crucial if we are to understand the role that science has played in the everyday life of people. Especially since what has been labeled sports physiology was much broader and influential in many areas of society that dealt with the body in different ways. The dissertation thus corroborates the view that history of science should not only look at the scientific institutions themselves, but also at the alternative, traditional practices that science has tried to replace with more rationalistic models, and the ways in which public practice has contributed to science through questioning, adapting and developing scientific knowledge into practical applications. Turning the attention in history of science more to the users of scientific knowledge in practical endeavors such as skiing may prove as fruitful as the turn towards users in history of technology called for by David Edgerton and others.¹⁵⁵ The reception, or rather the mediation and negotiation of scientific knowledge in contexts where practitioners have challenged scientists for the role of experts, can say a lot about science itself.

Today we have a situation where exercisers voluntarily subject themselves to extensive quantification. While skiers in the 1950s refused to share their training logs with anyone, many now post much more detailed logs on social media. The training logs and training manuals handed out by the Swedish Ski Association in the 1950s were first steps in a journey that has transformed sports from a private matter into something much more elaborate and public.

The way in which we understand the scientific impact on sports during the 20th century is also about our own preferences. During the work with this dissertation I have been critiqued for romanticizing natural training, but also for undervaluing it. I have been read as a supporter of scientific transformation of sports, as well as an opponent. The truth is somewhere in the middle. I am a passionate runner and skier and I prefer doing these activities outdoors, in mountains or forests. I played (or impersonated, some might say) a left back in sixth division football for many years, much for the beauty of all the rural, far-from-standardized football fields we visited. But I am also impressed by the scientific achievements that have allowed even exercisers to really compete against themselves, to get detailed information about their performance and based on that information drive their bodies

¹⁵² Edgerton, David (2007). *The shock of the old: technology and global history since 1900*. New York: Oxford University Press, p. 3-5 et passim.

¹⁵³ Edgerton, *The shock of the old*.

¹⁵⁴ Pennell, Sara (2016). *The Birth of the English Kitchen, 1600-1850*. New York: Bloomsbury Publishing, p. 14.

¹⁵⁵ Edgerton, *The shock of the old*.

further. I always run and ski with a GPS pulse watch on my arm. Am I thus a victim of Foucauldian *bio-power*? Maybe so, but have we not always been disciplined in sports, just by a different set of ideals and standards? When my grandfather played bandy on lakes and rivers in the 1940s and 1950s, he sometimes was a goalkeeper, without gloves, in minus 20 degrees Celsius trying to catch the rock hard bandy ball. As much as I love his stories, was he not also as disciplined by ideas about manliness and toughness as we are today by specialized, super-commercial and scientifically tested gloves? The seemingly innocent use of scientific testing, training logs and other micro-technologies in the 1950s was the first steps in a development leading up to the quantified exercisers measuring their own performance by scientifically inspired equipment today. From elite skiers who refused to share their training logs with the Swedish Ski Association, to everyday exercisers posting their logs online – there has indeed been a change in how we perceive quantification, privacy and expertise that may lead us to conclude that the rational training model “won”. However, this does not only indicate that we have succumbed to techno-scientific visions of productivity. The quantified self-movement and all of the data we produce today also allows for individualization, making athletes less dependent on scientists while simultaneously being more dependent on scientific knowledge tradition. This brings us back to the transformative power of sports. It has been suggested that sports can be an arena for transformation of gender roles, for emancipation, for personal development, for recognition of rights.¹⁵⁶ If anything, the history of training in elite cross-country skiing shows that there are different ways to win and that the seemingly constant features of sports (men don’t wear gloves, women don’t play football, skiers don’t like science, sport scientists don’t understand skiing) are in fact in constant flux, transformed in every training session and competition. For me, that is the true power of training and sports.

¹⁵⁶ Barker-Ruchti, Grahn & Lindgren, 'Shifting, crossing and transforming gender boundaries in physical cultures'. Andersen and Loland, "Jumping for recognition: Women's ski jumping viewed as a struggle for rights".

References

- Albert de la Bruhèze, Adri A. and Oldenziel, Ruth (eds.) (2009). *Manufacturing technology, manufacturing consumers: the making of Dutch consumer society*. Amsterdam: Aksant.
- Alberts, Gerard and Oldenziel, Ruth (2014). *Hacking Europe: From Computer Cultures to Demoscenes*. London: Springer.
- Allen-Collinson, J (2013). "Autoethnography as the engagement of self/other, self/culture, self/politics, selves/futures", in S Holman Jones, T E Adams & C Ellis (eds), *Handbook of Autoethnography*. Walnut Creek, CA: Left Coast Press, pp. 281-299.
- Alnæs, Karsten (2007). *Jeg spenner mine ski: historien om norsk skikultur*. Oslo: Aschehoug.
- Alsgaard, Thomas and Karlsen, Marit (2008). *Best på ski: Trening, teknikk, kosthold, konkurranse*. Oslo: Tun.
- Andersen, Wivi and Loland, Sigmund (2016). "Jumping for recognition: Women's ski jumping viewed as a struggle for rights", in *Scandinavian Journal of Medicine & Science in Sports*. DOI: 10.1111/sms.12662.
- Anderson, Leon (2006). "Analytical Autoethnography", in *Journal of Contemporary Ethnography*, vol. 35 no. 4, pp. 373-395.
- Andersson, Frida, Vångell, Fredrika and Yttergren, Leif (2011). "Orienteringsträning i förändring: En komparativ studie av orienteringsträning på elitnivå på 1980-talet och 2010". Malmö: Idrottsforum.org/Nordic sport science forum.
- Andersson, Roger (2007). *IK Ymer jubileumsbok. D. 1, Några ögonblick ur 90 år*. Borås: Idrottsklubben Ymer.
- Armiero, Marco (2011). *A Rugged Nation: Mountains and the Making of Modern Italy: Nineteenth and twentieth centuries*. Knapwell, Cambridge: White Horse Press.
- Backman, Olle (2011). *Nordenskiöldsloppet 1884: historien om världens hårdaste skidtävling*. Helsingfors: Nordenskiöldsamfundet i Finland.
- Bailey, Steve (1996). *Science in the service of physical education and sport: the story of the International Council of Sport Science and Physical Education, 1956-1996*. Chichester: Wiley.
- Barker-Ruchti, Natalie, Grahn, Karin & Lindgren, Eva-Carin (2015). "Shifting, crossing and transforming gender boundaries in physical cultures", in *Sport in Society: Cultures, Commerce, Media, Politics*. DOI: 10.1080/17430437.2015.1073942.
- Bairner, Alan (2009). "National sports and national landscapes: In defence of primordialism", in *National Identities*, 11:3, pp. 223-239.
- Bajic, Blaz, (2014). "Running as nature intended: barefoot running as enskillment and away of becoming", in *Anthropological Notebooks*, 20 (2), pp. 5–26.
- Bale, John (2003). *Sports geography*. London: Routledge.

- Bale, John & Sang, Joe (1996). *Kenyan running: movement culture, geography, and global change*. London: Frank Cass
- Bandy, Susan J. (2016). "Gender and the 'cultural turn' in the study of sport and physical cultures", in *Sport in Society*, 19:5, pp. 726-735.
- Bassett, David R. (2002). "Scientific contributions of A.V. Hill: exercise physiology pioneer", in *Journal of Applied Physiology*, 93, pp. 1567-1582.
- Batagelj, Borut (2013). "Slovenian Skiing Identity: Historical Path and Reflection", in *The International Journal of the History of Sport*, 30:6, pp. 647-658.
- Bergh, Ulf (ed.) (1974). *Längdloppning på skidor: träningsråd (English title: Cross-country skiing: training advice)*. Bjästa: CeWe-förlaget
- Björck, Henrik (2008). *Folkhemsbyggare*. Stockholm: Atlantis.
- Bolling, Hans (2005). *Sin egen hälsas smed: idéer, initiativ och organisationer inom svensk motionsidrott 1945-1981*. Stockholm: Stockholms universitet.
- Borgås, Göran (1988). *IFK Ulricehamn 50 år: 50 år med IFK*. Ulricehamn: IFK Ulricehamn.
- Bourne, Nicholas D. (2008). *Fast science: a history of training theory and methods for elite runners through 1975*. Ann Arbor, MI: ProQuest.
- Briandt, Calle (1962). *Träningsråd i längdloppning (English title: Training advice for cross-country skiing)*. Stockholm: Swedish Ski Association.
- Bromber, Katrin, Krawietz, Birgit and Petrov, Petar (2014). "Wrestling in Multifarious Modernity", in *The International Journal of the History of Sport*, 31:4, pp. 391-404.
- Bø, Olav (1993). *Skiing throughout history*. Oslo: Norske Samlaget
- Carter, Neil (2012). *Medicine, Sport and the Body. A Historical Perspective*. London: Bloomsbury.
- Carter, Neil (2010). "The Rise and Fall of the Magic Sponge: Medicine and the Transformation of the Football Trainer", in *Social History of Medicine*, vol. 23, no. 2, pp. 261-279.
- Chang, Heewon (2016). "Autoethnography in Health Research: Growing Pains?", in *Qualitative Health Research*, vol. 26 no. 4, pp. 443-451.
- Coffey, A. (1999). *The Ethnographic Self: Fieldwork and the Representation of Identity*. London: Sage.
- Collinet, Cécile, Delalandre, Matthieu, Schut, Pierre-Olaf & Lessard, Coralie (2013). "Physical Practices and Sportification: Between Institutionalisation and Standardisation. The Example of Three Activities in France", in *The International Journal of the History of Sport*, 30:9, pp. 989-1007.
- Dahlstedt, Helge (1927). *Skididrotten, skolan och ungdomens fysiska fostran*. Malmö.
- De Geer, Hans (1978). *Rationaliseringsrörelsen i Sverige: effektivitetsidéer och socialt ansvar under mellankrigstiden [The Rationalization Movement in Sweden: Efficiency Programs and Social Responsibility in the Interwar Years]*. Stockholm: SNS.

- Dennis, Mike and Grix, Jonathan (2012). *Sport under communism: behind the East German 'miracle'*. Basingstoke: Palgrave Macmillan.
- Dumont, Guillaume (2014). "Aesthetics of attachments: Reflexive insights on taste construction in climbing", in *European Journal for Sport and Society*, 11:4, pp. 371-387.
- Edgerton, David (2007). *The shock of the old: technology and global history since 1900*. New York: Oxford University Press.
- Edwards, Allan and Skinner, James (2006). *Sport Empire*. Oxford: Meyer and Meyer Sport.
- Ekblom, Björn and Huot, Roger (1972). "Response to Submaximal and Maximal Exercise at Different Levels of Carboxyhemoglobin", in *Acta Physiologica Scandinavica*, 86(4), pp.474-482.
- Ekblom, B., Goldbarg, A. N., Gullbring, B. (1972). "Response to exercise after blood loss and reinfusion", in *Journal of Applied Physiology*, 33(2), pp.175-180.
- Ekblom B. (1972). "Will Blood Doping Become a New Sport Problem?" [Swedish title: "Blir 'bloddoping' ett nytt idrottsproblem?"], in *Svensk Idrott*, 1972:11, pp. 293-295.
- Ekenstam, Claes (2006). *Kroppens idéhistoria: disciplinering och karaktärsdaning i Sverige 1700-1950*. Hedemora: Gidlund
- Emanuel, Martin (2012). *Trafikslag på undantag: cykeltrafiken i Stockholm 1930-1980*. Stockholm: Kungliga tekniska högskolan.
- Engel, Peter (2013). "The Discursive Construction of National Identity through the Swiss Magazine SKI Before World War I", in *The International Journal of the History of Sport*, 30:6, pp. 598-616.
- Folk, G. Edgar and Thrift, Diana L. (2010). "The Harvard Fatigue Laboratory: contributions to World War II", in *Advances in Physiology Education*, 2010:34, pp. 119-127.
- Forsman, Bengt (ed.) (2001). *100 år av idrottshistoria: IFK Umeå 100 år, 1901-2001*. Umeå: Idrottsfören. Kamraterna.
- Foucault, Michel (1998). *The Will to Knowledge. The History of Sexuality, Vol. 1*. New York: Penguin Books.
- Fundberg, Jesper (2003). *Kom igen, gubbar! Om pojkfotboll och maskuliniteter*. Stockholm: Carlssons.
- Goksøyr, Matti (1988). *Sivilisering, modernisering, sportifisering: fruktbare begreper i idrettshistorisk forskning?*. Oslo.
- Goksøyr, Matti (1996). "'Sportsmanship' in a bourgeois town: Disciplining and character-building or posing and production of status? The role of the emerging sport in the city of Bergen in the last decades of the 19th century", in *Scandinavian Journal of History*, 21: 2, pp. 135-149.
- Goksøyr, Matti. "Skis as National Symbols, Ski Tracks as Historical Traits: The Case of Norway", in *2002 International Ski History Congress*, edited by E. John B. Allen, pp. 197– 203. New Hartford: International Skiing History Association, 2002.
- Gotaas, Thor (2010). *Først i løypa: historien om langrenn i Norge*. Oslo: Dreyer.

- Gotaas, Thor (2007). *Skimakerne: historien om norske ski*. Oslo: Gyldendal.
- Gotaas, Thor (2011). *Norway – the Cradle of Skiing*. Nesøya: Font Forlag.
- Gori, Gigliola (ed.) (2008). *Sport and gender matters in western countries: old borders and new challenges*. Sankt Augustin: Academia Verlag.
- Grant, Susan (2013). *Physical culture and sport in Soviet society: propaganda, acculturation, and transformation in the 1920s and 1930s*. New York: Routledge.
- Groenen, Haimo (2014). "La préparation des premières Olympiades de judo en France entre 1960 et 1964: un facteur de sportivisation de l'entraînement et de la discipline japonaise", in *European Studies in Sports History*, no 7: 2014.
- Guttman, Allen (1978). *From Ritual to Record. The Nature of Modern Sports*. New York: Columbia University Press.
- Haake Steve (2009). "The Impact of technology on sporting performance in Olympic Games", in *Journal of Sport Sciences*, 27.13 (2009), pp. 1421-1431.
- Hagberg, Jan-Erik (1986). *Tekniken i kvinnornas händer: hushållsarbete och hushållsteknik under tjugo- och trettitalen*. Malmö: Liber.
- Hedenborg, Susanna (2008). "Enkelt fältgrått och amasoner i topp: ryttarolympiaden 1956 analyserad ur genus- och klassperspektiv", in *Idrott, historia och samhälle*, 2008, pp. 69-91.
- Heggie, Vanessa (2011). *A History of British Sport Medicine*. Manchester: Manchester University Press.
- Hellspong, Mats (2000). *Den folkliga idrotten: studier i det svenska bondesamhällets idrotter och fysiska lekar under 1700- och 1800-talen*. Stockholm: Nordiska museets förlag.
- Henschen, Salomon E. (1898). "Om Skidlöpning och Skidtäfling ur medicinsk synpunkt", in *Uppsala Universitets årsskrift 1897*. Uppsala: Uppsala Universitet.
- Hill, Jeff, Moore, Kevin & Wood, Jason (eds.) (2012). *Sport, history, and heritage: studies in public representation*. Woodbridge, UK: Boydell Press.
- Hirdman, Yvonne (2010). *Att lägga livet till rätta*. Stockholm: Carlsson Bokförlag.
- Hjelm, Jonny (2004). *Amasoner på planen: svensk damfotboll 1965-1980*. Umeå: Boréa.
- Hoberman, John M. (1992). *Mortal Engines: The Science of Performance and the Dehumanization of Sport*. New York: Free Press.
- Hoff, Jan and Helgerud, Jan (eds.) (2002). *Football (soccer): new developments in physical training research*. Trondheim: NTNU.
- Hohwü-Christensen, Erik (1943). "GCI:s fysiologiska institution", in *Tidskrift i gymnastik*, nr. 3, 1943.
- Hohwü-Christensen, Erik (1943). "Förslag till ny utbildningsplan för lärare i gymnastik, lek och idrott", in *Tidskrift i gymnastik*, nr. 10, 1943.
- Holmér, Gösta (1943). *Vägen till rekorden: instruktionsbok i fri idrott*. Stockholm: Swings sportdepå.

- Holt, Richard (1989). *Sport and the British: a modern history*. Oxford: Clarendon.
- Horton, Peter (2012). "The Asian Impact on the Sportisation Process", in *The International Journal of the History of Sport*, 29:4, pp. 511-534.
- Horvath, Steven M. and Horvath, Elizabeth C. (1973). *The Harvard Fatigue Laboratory: Its History and Contributions*. Englewood Cliffs, NJ: Prentice Hall.
- Howe, P. David (2006). "Habitus, Barriers and the [Ab]use of the Science of Interval Training in the 1950s", in *Sport in History*, vol. 26, no. 2, pp. 325-344.
- Hutchins, Brett (2008). "Signs of meta-change in second modernity: the growth of e-sport and the World Cyber Games", in *New Media & Society*, 10:6, pp. 851-869.
- IK Stern (1984). *Idrottsklubben Stern: 50 år med Idrottsklubben Stern 1934-1984*. Göteborg: IK Stern.
- Jamison, Andrew (1982). *National Components of Scientific Knowledge. A Contribution to the Social Theory of Science*. Lund: Research Policy Institute.
- Johannisson, Karin (1991). *Folkhälsa: det svenska projektet från 1900 till 2:a världskriget*. Lychnos, 1991, p. 139-195.
- Johnson, Andi (2015). "'They Sweat for Science': The Harvard Fatigue Laboratory and Self-Experimentation in American Exercise Physiology", in *Journal of the History of Biology*, 48:3, pp. 425-454.
- Johnson, Andi (2009). *Human Performance. An Ethnographic and Historical Account of Exercise Physiology*. Ann Arbor, MI: Proquest.
- Jonasson, Kalle and Thiborg, Jesper (2010). "Electronic sport and its impact on future sport", in *Sport in Society*, 13:2, pp. 287-299.
- Jonsson, Kjell (1986). "En nybadad renrasig svensk på ett blankskurat furugolv i ett hus utan löss i ett genomskinligt samhälle där vetenskapsmannen ser till att fabrikerna tillverkar foträta skor och ingen är så dum att han på fotboll glor: Hjalmar Öhrvalls person-, bostads-, mental- och rashygien såsom samhällsvision", in *I framtidens tjänst*, 1986, pp. 102-126.
- Kaijser, Arne and Sax, Ulrika (2013). *A tribute to the memory of Brita Åkerman (1906-2006), Carin Boalt (1912-1999): presented at the 2013 Annual Meeting of the Royal Swedish Academy of Engineering Sciences*. Stockholm: Royal Swedish Academy of Engineering Sciences (IVA).
- Karlsson, Nils (1953). *I vita spår*. Stockholm: Bonnier.
- Karlsson, Håkan (2008). "Mellan kanon, dialog och fotboll – kulturarvets demokratiska potential", in Jönsson, Lars-Eric, Wallete, Anna och Wienberg, Jes (eds.), *Kanon och kulturarv. Historia och samtid i Danmark och Sverige*. Göteborg/Stockholm: Makadam.
- Karlsson, Håkan (2010). "Fotbollens idrottshistoriska platser. Ett försummat kulturarv", in *Idrott, Historia, Samhälle*, 2010, pp. 84-100.
- Kasperowski, Dick (2009). "Constructing Altitude Training Standards for the 1968 Mexico Olympics: The Impact of Ideals of Equality and Uncertainty", in *The International Journal of the History of Sport*, 26:9, pp. 1263-1291.

Kayser Nielsen, Niels (1997). "Movement, Landscape and Sport. Comparative Aspects of Nordic Nationalism between the Wars", in *Ethnologia Scandinavica*, Vol. 27, pp. 84-98.

Kimura, Machiko (2003). "The genealogy of power: historical and philosophical considerations about doping", in *The International Journal of Sport and Health Science*, 1:2, pp. 222-228.

Koselleck, Reinhart (2002). *The practice of conceptual history: timing history, spacing concepts*. Stanford, California: Stanford University Press.

Krüger, Arnd (2006). "Training Theory and Why Roger Bannister was the First Four-Minute Miler", in *Sport in History*, 26:2, pp. 305-324.

Krüger, Arnd (1997). "The History of Middle and Long Distance Running in the Nineteenth and Twentieth Century", in *La Comune Eredita' dello Sport in Europa: Atti del I Seminario Europeo di Storia dello Sport*, edited by Arnd Krüger and Angela Teja, pp. 117-124. Rome: CONI.

Kvärre, Stellan (2009). *IFK Mora: de första 100 åren*. Mora: Dala media.

Lagergren, Lars (2003). "Elitutbildningar inom kultur- och upplevelseindustrin", in Sörlin, Sverker (ed.) *Kulturen i kunskapssamhället – Om kultursektorns tillväxt och kulturpolitikens utmaningar*. Nora: Nya Doxa, pp. 59-76.

Larsson, Håkan (2011). "Sport physiology research and governing gender in sport—a power-knowledge relation?", in *Sport, Education and Society*.

Larsson von Garaguly, Joacim (2016). *Vasaloppet - resan från skidtävling och skidlöpare till produkter och kunder: en studie om kommersialisering och professionalisering*. Stockholm: Handelshögskolan.

Latham, Alan (2015). "The history of a habit: jogging as a palliative to sedentariness in 1960s America", in *Cultural Geographies*, vol. 22(1), pp. 103-126.

Lindroth, Jan (1974). *Idrottens väg till folkrörelse: studier i svensk idrottsrörelse till 1915* [English title: *Athletics becomes a popular movement: studies in the Swedish athletics movement up until 1915*]. Uppsala: Uppsala University.

Little, Michael A., Thomas, R. Brooke and Garruto, Ralph M. (2013). "A Half Century of High-Altitude Studies in Anthropology: Introduction to the Plenary Session", in *American Journal of Human Biology*, nr. 25, pp. 148-150.

Ljunggren, Jens (1999). *Kroppens bildning: Linggymnastikens manlighetsprojekt 1790-1914*. Eslöv: Symposion.

Ljunggren, Jens (2000). "The masculine road through modernity: Ling gymnastics and male socialisation in nineteenth-century Sweden", in *Making European masculinities*, 2000, pp. 86-111.

Lundin, Per (2008). *Bilsamhället: ideologi, expertis och regelskapande i efterkrigstidens Sverige*. Stockholm: Kungliga tekniska högskolan.

Lundquist Wanneberg, Pia (2004). *Kroppens medborgarfostran: kropp, klass och genus i skolans fysiska fostran 1919-1962*. Stockholm: Stockholms universitet.

- Lövgren, Britta (1993). *Hemarbete som politik: diskussioner om hemarbete, Sverige 1930-40-talen, och tillkomsten av Hemmens forskningsinstitut*. Stockholm: Stockholms Universitet.
- Löwdin, Inga (1994). "Tillbakablick på skidornas damlängdlöpning som tävlingsport 1880-1965", in *Idrott, historia och samhälle*, 1994.
- MacKenzie, John M. (1988). *The empire of nature: hunting conservation and British Imperialism*. Manchester: Manchester University Press.
- Marklund, Pelle (2000). *Det stora äventyret: Vasaloppet under 1900-talet*. Västerås: Sportförlaget.
- Martin, Luther H., Gutman, Huck and Hutton, Patrick H. (eds.) (1988). *Technologies of the self: a seminar with Michel Foucault*. Amherst, Univ. of Massachusetts Press, 1988.
- Martinell, Vidar (1999). *Skidsportens historia, Längd 1800-1949*. Järna: Martinell.
- Martinell, Vidar (2001). *Skidsportens historia, Längd 1950-1979*. Järna: Martinell.
- Martinell, Vidar (2003). *Skidsportens historia, Längd, 1980-1999*. Järna: Martinell.
- Mattsson, Mikael C. and Holmberg, Hans-Christer (2012). "Intervallträningen som ger guld", in *Svensk Idrottsforskning*, 2012:2, p. 44-49.
- Matveyev, L.P. (1965). *Periodization of Sports Training*. Moscow: Fiskultura i Sport.
- McDougall, Christopher (2009). *Born to run: the hidden tribe, the ultra-runners, and the greatest race the world have ever seen*. London: Profile Books.
- McIntosh, Peter (ed.) (2007). *Landmarks in the history of physical education*. London: Routledge & Kegan Paul.
- Mechikoff, Robert A. and Estes, Steven (2009). *A history and philosophy of sport and physical education: from ancient civilizations to the modern world*. 5. ed. Boston, MA: McGraw-Hill.
- Morris, Andrew D. (2004). *Marrow of the nation: a history of sport and physical culture in Republican China*. Berkeley, CA: University of California Press.
- Morrow, Don and Wamsley, Kevin B. (2005). *Sport in Canada: a history*. Don Mills, Ont.: Oxford University Press.
- Nybelius, Marit Stub and Hofmann, Annette R. (eds.) (2015). *License to jump!: a story of women's ski jumping*. Spånga: Beijbom books
- OK Landehof (2006). *OK Landehof: 1955-2005: 50 år*. Landvetter: Orienteringsklubben Landehof.
- Olander, Gösta (1948). *Träningsråd för skidåkare*. Stockholm: Svenska skidförbundet.
- Oldenziel, Ruth & Zachmann, Karin. (eds.) (2009). *Cold War kitchen: Americanization, technology, and European users*. Cambridge, Mass.: MIT Press
- Park, Roberta J. (2011). "Physicians, Scientists, Exercise and Athletics in Britain and America from the 1867 Boat Race to the Four-Minute Mile", in *Sport in History*, 31:1, pp. 1–31.

- Park Roberta J. (2014). "Play, Games and Cognitive Development: Late Nineteenth-Century and Early Twentieth-Century Physicians, Neurologists, Psychologists and Others Already Knew What Researchers Are Proclaiming Today", in *The International Journal of the History of Sport*, 31.9, pp. 1012-1032.
- Pedersen, Helge Chr. (2013). "Skiing and Sport in the Core Sámi Area of Norway, 1927 to 1964: Organisation, Modernisation and Minority Policy", in *The International Journal of the History of Sport*, vol. 30, nr. 6, pp 580-597.
- Pennell, Sara (2016). *The Birth of the English Kitchen, 1600-1850*. New York: Bloomsbury Publishing.
- Peterson, Tomas (1993). *Den svengelska modellen: svensk fotboll i omvandling under efterkrigstiden*. Lund: Arkiv
- Pfister, Gertrud (2003). "Cultural confrontations: German Turnen, Swedish gymnastics and English sport – European diversity in physical activities from a historical perspective", in *Culture, Sport, Society*, vol. 6, Issue 1, pp. 61-91.
- Pihl Atmer, Ann Katrin and Lindroth, Jan (eds.) (2001). *Idrottens platser*. Uppsala: Swedish Science Press.
- Qviström, Mattias (2016). "The nature of running: On embedded landscape ideals in leisure planning", in *Urban Forestry & Urban Greening*, 17:1, pp. 202–210.
- Qviström, Mattias (2013). "Landscapes with a heartbeat: tracing a portable landscape for jogging in Sweden (1958–1971)", in *Environment and Planning A*, 45, pp. 312–328.
- Rabinbach, Anson (1990). *The Human Motor. Energy, Fatigue, and the Origins of Modernity*. New York: Basic Books.
- Rambusch, Jana, Jakobsson, Peter and Pargman, Daniel (2007). "Exploring E-sports: A case study of game play in Counter-strike", in *Proceedings of Situated Play: Digital Games Research Association (DiGRA) 2007 Conference*, Tokyo, Japan.
- Reid, Vybarr (2012). "Running Wilde: Landscape, the Body, and the History of the Treadmill", in *Critical Survey*, vol. 24(3), pp.73-91.
- Reindell, Herbert et al. (1962). *Das Intervalltraining*. München.
- Renström, Per and Karlsson, Jon (2003). "En resa i tiden med svensk idrottsmedicin", in *Svensk idrottsforskning*, 2010:3, pp. 4-9.
- Roger, Anne (2005). "Das Training der französischen Mittlestreckler (1945-1970). Auf der Suche nach einer französischen Methode", in Jürgen Buschmann & Stephan Wassong (eds.), *Langlauf durch die olympische Geschichte. Festschrift Karl Lennartz*. Köln: Carl-und-Liselott-Diem-Archiv, pp. 405-429.
- Roger, Anne, and Terret, Thierry (2011). *European Athletics. A Continental History of Track and Field (1912–2010)*. Stuttgart: Neuer Sportverlag.

- Roth, Wolff-Michael (ed.) (2005). *Auto/biography and auto/ethnography: praxis of research method*. Rotterdam: Sense Publishers.
- Rouse, Paul (2015). *Sport and Ireland: a history*. First edition.
- Sandbakk, Øyvind and Tønnesen, Espen (eds.) (2012). *Den norske langrennsboka*. Oslo: Aschehoug.
- Sandblad, Henrik (1985). *Olympia och Valhalla: idéhistoriska aspekter av den moderna idrottsrörelsens framväxt* [English title: *Sport and ideas: aspects of the rise of the modern sport movement*]. Grillby: Lärdomshistoriska samfundet.
- Santesson, Anton B. (1880). *Ur naturen och samhället*. Stockholm: Albert Bonniers förlag.
- Schantz, Peter (2015). "Along paths converging to Bengt Saltin's early contributions in exercise physiology", in *Scandinavian Journal of Medicine and Science in Sports*, 25(Suppl. 4), pp. 7-15
- Schiller, Kay and Young, Christopher (2009). "The History and Historiography of Sport in Germany: Social, Cultural and Political Perspectives", in *German History*, 27:3, pp. 313-330.
- Sjöblom, Paul (2006). *Den institutionaliserade tävlingsidrotten: kommuner, idrott och politik i Sverige under 1900-talet*. Stockholm: Stockholms universitet.
- Sjöblom, Paul and Fahlén, Josef (2010). "The survival of the fittest: intensification, totalization and homogenization in Swedish competitive sport", in *Sport in Society: Cultures, Commerce, Media, Politics*, 13:4, pp. 704-717.
- Skjeldal, Gudmund (2014). *Nestbest: Ei personlig idéhistorie om bronse, sølv og gull*. Oslo: Cappelen Damm.
- Sommestad, Lena (1992). *Från mejerska till mejerist: en studie av mejeriyrkets maskuliniseringsprocess*. Lund: Arkiv.
- Sund, Bill (2012). *Backe upp och backe ner: Svensk cykelsport och cykelhistoria i ett internationellt perspektiv*. Malmö: Idrottsforum.org.
- Swedish Ski Association (1958). *Styrelseberättelse 1957-58*. Stockholm: Swedish Ski Association.
- Swedish Ski Association (1970). *Åk skidor*. Täby: Larson.
- Svensson, Daniel and Oppenheim, Florence (2015). *Etta på bollen: Historien om Öxabäcks damlag*. Landvetter: Oppenheim.
- Svensson, Daniel (2013). "How Much Sport is there in Sport Physiology? Practice and Ideas in the Stockholm School of Physiology at GCI, 1941–1969", in *The International Journal of the History of Sport*, vol. 30, no. 8, pp. 892-913.
- Svensson, D., Sörlin, S. and Wormbs, N. (2015). "The movement heritage – scale, place, and pathscales in Anthropocene tourism", in Gren, Martin and Huijbens, Edward (eds.), *Tourism and the Anthropocene*, London: Routledge, pp. 131-151.
- Söderberg, Benkt (1998). *Tre perspektiv på idrott och medicinvetenskap, 1900–1930* [Three Perspectives on Sports and Medicinal Science, 1900–1930]. Stockholm: Idrottshistoriska specialseminariet, Historiska Institutionen, Stockholm University.

- Sörlin, Sverker (2014). *Rädslan för svaghet: en berättelse om sjukdom, smärta och löje*. [English title: *The fear of weakness*]. Stockholm: Weyler.
- Sörlin, Sverker (2010). *Kroppens geni: Marit, Petter och skidåkning som lidelse*. Stockholm: Weyler.
- Sörlin, Sverker (1995). "Nature, Skiing and Swedish Nationalism", in *The International Journal of the History of Sport*, 1995, vol. 12 (2), pp. 147-163.
- Sörlin, Sverker (1998). "Monument and memory", in *Worldviews: Global Religions, Culture, and Ecology*, 2(3), pp. 269–279.
- Sörlin, Sverker (1999). "The articulation of territory: landscape and the constitution of regional and national identity", in *Norsk Geografisk Tidsskrift – Norwegian Journal of Geography*, 53:2-3, pp. 103-112.
- Sörlin, Sverker (2011). "En nasjon krysser sitt spor: Konger, helgener og 'banal nasjonalisme' i den evige snøens rike", in *Samtiden*, 122(2011):1, pp.66-83.
- Taylor, T.L. (2012). *Raising the stakes: E-sports and the professionalization of gaming*. Cambridge MA: MIT Press.
- Thiborg, Jesper (2011). *Att göra (e)sport : om datorspel och sportifiering*. Örebro : Örebro universitet.
- Thieme, Detlef and Hemmersbach, Peter (eds.) (2010). *Handbook of experimental pharmacology, vol. 195, Doping in sports*. Berlin: Springer.
- Tipton, Charles M. (2014). "The history of 'Exercise Is Medicine' in ancient civilizations", in *Advances in Physiology Education*, 38:2, pp. 109-117.
- Tipton, Charles M. (2003) (ed.). *Exercise Physiology. People and Ideas*. New York: Oxford University Press.
- Tipton, Charles M. (2014). "Chapter 1. Antiquity to the Early Years of the 20th Century", in Charles M. Tipton, *History of Exercise Physiology*. Champaign IL, Human Kinetics, p. 3-32.
- Tolvhed, Helena (2008). *Nationen på spel: kropp, kön och svenskhet i populärpressens representationer av olympiska spel 1948-1972*. Umeå: h:ström - Text & kultur.
- Tolvhed, Helena (2015). *På damsidan: femininitet, motstånd och makt i svensk idrott 1920-1990*. Göteborg: Makadam.
- Uebel, Maja (2006). *Nya perspektiv på riksidrottsgymnasierna - Vad flickor och pojkar värdesätter i RIG-verksamheten*. Stockholm: Swedish Sports Confederation.
- Vaage, Jakob (1977). *Skismøringens historie*. Skårer: Swix Sport International.
- Wengraf, Tom (2001). *Qualitative research interviewing: biographic narrative and semi-structured methods*. Thousand Oaks, Calif.: SAGE.
- Wicken, Ingrid P. (2012). *Lost Ski Areas of Southern California*. California: The History Press.
- Wigernaes, Ingrid (1967). *Mot mål med jentutn*. Oslo: Aschehoug.

Wolfe Scheffler, Robin (2015). "The Power of Exercise and the Exercise of Power: The Harvard Fatigue Laboratory, Distance Running, and the Disappearance of Work, 1919–1947", in *Journal of the History of Biology*, 2015:48, pp. 391–423.

Wrynn, Alison M. (2010). "The Athlete in the Making: The Scientific Study of American Athletic Performance, 1920–1932", in *Sport in History*, 30:1, pp. 121–137.

Wulff, Helena (2009). *Dancing at the crossroads: memory and mobility in Ireland*. New York: Berghahn Books.

Yesalis, C.E. and Bahrke, M.S. (eds.) (2002). *Performance-Enhancing Substances in Sport and Exercise*. Champaign, IL: Human Kinetics.

Yttergren, Leif (1996). *Täflan är lifvet: idrottens organisering och sportifiering i Stockholm 1860-1898*. Stockholm: Stockholmia.

Yttergren, Leif (2012). *Träna är livet: träning, utbildning och vetenskap i svensk friidrott, 1888–1995*. Malmö: idrottsforum.org.

Yttergren, Leif (2015). "The Professionalisation and scientification of athletics training in Sweden 1910-1957: Two examples: Ernie Hjertberg and Gösse Holmer", in *Stadion: Internationale Zeitschrift für Geschichte des Sports*, vol. 40 (2014), no. 1, pp. 57-71.

Åstrand, Per-Olof (1988). "Fysiologiska institutionens tillkomst och utveckling", in Halldén, Olle (ed.), *Festskrift vid GCI-GIH:s 175-årsjubileum*. Stockholm: Gymnastik- och idrottshögskolan.

Websites

Aalto University, "Competitive programming." <http://cs.aalto.fi/en/studies/competitive_programming/>. Retrieved 2016-08-26.

Norrländska Socialdemokraten, "Sexskandal skakar skidgymnasiet". <<http://www.nsd.se/nyheter/sexskandal-skakar-skidgymnasiet-7496395.aspx>>. Retrieved 2016-07-18.

Olympic.org, "The Olympic symbols". <http://www.olympic.org/Documents/Reports/EN/en_report_1303.pdf>. Retrieved 2016-05-01.

KTH Royal Institute of Technology, "Tävlingsprogramering", <<http://www.csc.kth.se/contest/>>. Retrieved 2016-05-04.

Swedish Academy Dictionary online, search phrase: rationell. <<http://www.saob.se/fritextsok/>>. Retrieved 2016-04-25.

Swedish Academy Dictionary online, search phrase: träna. <<http://www.saob.se/fritextsok/>>. Retrieved 2016-04-25.

Swedish association for sport history. "Om SVIF". <<http://www.svif.net/omsvif.htm>>. Retrieved 2016-07-13.

The Swedish Sports Confederation. <<http://www.rf.se>>. Retrieved 2016-07-14.

The International Skiing History Association (ISHA), official website. Bengtsson, Bengt Erik (n.d.). "Cross-country skating: how it started". <<https://www.skiinghistory.org/history/cross-country-skating-how-it-started>>. Retrieved 2016-05-01.

The International Skiing History Association (ISHA). Masia, Seth. "Grip and glide: a short history of ski wax". <<https://www.skiinghistory.org/history/grip-and-glide-short-history-ski-wax>>. Retrieved 2016-07-04.

The International Skiing History Association (ISHA), official website. "Skiing History Magazine". <<https://www.skiinghistory.org/skiing-history-magazine>>. Retrieved 2016-07-14.

University of Massachusetts Boston, "Competitive programming". <https://www.umb.edu/academics/course_catalog/course_info/ugrd_CS_2016%20Spring_411>. Retrieved 2016-08-26.

Västerbottens Museum, official website, "The Ski Exhibition". Retrieved 2016-09-05 at: <<http://www.vbm.se/en/se-and-gora/utstallningar/skidutstallningen.html>>.

Interviews

Brå, Oddvar, interviewed 2014-03-11 in Trondheim.

Strandberg, Britt, phone interview 2015-01-13.