

Handbook of  
Sports Medicine  
and Science

# Canoeing



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An IOC  
Medical Commission  
Publication




EDITED BY

**Don McKenzie**  
**Bo Berglund**

WILEY Blackwell



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Handbook of Sports Medicine and Science

**Canoeing**

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# Handbook of Sports Medicine and Science **Canoeing**

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EDITED BY

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# Contents



- List of Contributors, vi  
Foreword by ICF President, viii  
Foreword by IOC President, ix  
Preface, x
- 1 Introduction, 1  
*Ian Mortimer and Don McKenzie*
- 2 Biomechanics and equipment (sprint and slalom): a review of scientifically confirmed information, 12  
*Barney Wainwright*
- 3 The canoe/kayak athlete, 40  
*Petra Lundström, Jorunn Sundgot Borgen, and Don McKenzie*
- 4 Physiology of canoeing, 47  
*Hans Rosdahl, Jose Calbet, A. William Sheel, and Robert Boushel*
- 5 Sport psychology for canoe and kayak, 62  
*Penny Werthner*
- 6 Training for canoeing, 71  
*Martin Hunter and Sylvain Curinier*
- 7 Medical problems in canoeing and kayaking, 91  
*Bo Berglund*
- 8 Orthopaedic injuries in canoeing, 97  
*Jozsef Dobos*
- 9 Paracanoes, 106  
*John Edwards, Anna Bjerkefors, Johanna Rosen, and Olga Tarassova*
- 10 Exercise performance in masters canoeing athletes, 116  
*Bo Berglund*
- 11 Diversity in canoe sport, 122  
*Don McKenzie and Kari-Jean McKenzie*
- Index, 133

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## Foreword



As President of the International Canoe Federation (ICF), it is my pleasure to welcome you to this excellent canoe-focused publication that is part of the International Olympic Committee's Handbooks on Sports Medicine and Science series.

Canoeing has always had a strong image as a healthy sport combining the highest levels of athletic achievement with spectacular locations. Throughout history, the margin of success or failure within our sport has been slim, and nowhere is this more prevalent than at the very highest level, the Olympic Games.

Canoeing has a rich and long history within the Olympic movement, with canoe sprint being introduced in 1924 and then becoming a full medal sport by the Berlin 1936 Olympic Games.

Slalom's Olympic journey started later when it debuted at the 1972 Munich Olympic Games. It then returned when the Games moved to Barcelona in 1992 and has been one of the core sports ever since.

Both disciplines have benefited greatly from their connection to the world's largest sporting celebration, as have the other seven disciplines that operate under the banner of our International Federation.

However, long before any athlete wins the honor to represent their nation at the highest level, they will need to dedicate their life to their chosen sport,

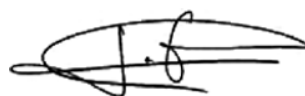
each day honing their skills, refining their diet, and building their strength to compete with the world's best.

It is this part of an athlete's life that goes unseen – the hours, days, weeks, months, and years of preparation that make an Olympic champion. This is where this publication sits, taking world-leading medical research and distilling it into a practical application for everyone within our sport to benefit.

On behalf of the entire international canoe community, the ICF authorities, and our many canoeists, I would like to extend my gratitude and compliments to the authors. Their contribution and ability to gather and then articulate such a complex body of research in a manner suitable for all is an amazing achievement and will inevitably help to further enhance the global development of our sport.

I congratulate and thank all those involved with this outstanding publication.

With my compliments,



José Perurena  
ICF President and IOC Member

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## Foreword

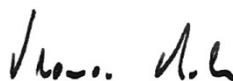


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Canoeing and kayaking have been an important part of the Olympic competitions for 70 years, for both men and women. At the Rio 2016 Olympic Games, competitions were held for men and women in four events for slalom (3M–1W) and 12 for sprint (8M–4W); and six events for kayak were held in the 2016 Paralympic Games.

The aim of this Handbook is to present the latest research dealing with the medicine and science of canoeing, organized by topic area chapters and presented with practical applications. Dr. Don McKenzie (Canada) was selected as editor for the project, and he successfully assembled a team of contributing authors who provided authoritative coverage of all aspects of the medicine and science of canoe/kayak competition.

The Handbook will most certainly constitute an invaluable working tool and source of guidance for medical doctors, related health personnel, and coaches who work with the athletes who participate at the international, national, and regional levels of competition. By joining the International Olympic Committee (IOC) Medical and Scientific Commission's Handbooks of Sports Medicine and Science series, this Handbook will serve as an important source of sports medicine and sports science information for many years to come.



Thomas Bach  
IOC President

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# Preface



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Few activities connect you to the environment like canoeing. As a sport, competitive canoe and kayak racing is unique, given the range of craft and water conditions. The International Canoe Federation is the governing body and provides leadership in nine disciplines. ParaCanoe, sprint, and slalom are well known due to their inclusion in the Olympic program. In these events, success is decided by objective measurement of time to complete a distance or course. The physical and mental preparation to compete is extreme, and these athletes challenge the limits of human performance. Control and integration of many factors are necessary to reach the podium.

The other disciplines are no less demanding. Marathon events require technical skill, tactics, and endurance over many kilometers. Freestyle competition involves acrobatics performed in whitewater on stationary river features. Points are given for spins, turns, and flips accumulated in a 60-second routine. Wild water competition represents the purity of effort, while racing downriver in class 2 to 4 whitewater. In Canoe ocean racing, competitors race in surfskis, sea kayaks, and single and six-person outriggers exposed to the wind and waves of the open ocean. There is a distinctive field of play and competition between teams in

Canoe polo. Teams of five-paddlers strive to score a ball into a net suspended above the water at each end of the pitch. Dragon boat has links to the cultural and traditional components of Canoeing. Originating in China more than 2000 years ago, current racing involves teams of 10 or 20 paddlers competing over distances from 200 to 2000 m.

This Handbook represents the efforts of experts in all areas of medicine and science applied to Canoeing. It provides general information on the history and development of Canoeing as well as specific chapters with concise, but detailed, information on sport science and the clinical aspects of Canoe sport. It is hoped that this Handbook will provide useful information to the athlete, coach, and support personnel as well as the reader interested in competitive and recreational canoeing.

It is a privilege to be included in the IOC series of Handbooks of Sports Medicine and Science. On behalf of the authors, we are indebted to Dr. Skip Knuttgen, paddler, scientist, and friend, who has guided us through the muddy waters of creating this Handbook. His expertise speaks for itself, and we owe him our gratitude.

Don McKenzie  
2018

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# Chapter 1

## Introduction

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### Introduction

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Bodies of water, great and small, are a formative feature of the human experience on our blue planet. At every corner of the earth, people have been drawn to live near these sources of life. This connection between humankind and the seas, oceans, and rivers that we call home is reflected in a seemingly universal reaction to not just live by and immerse ourselves in water, but also find a way to float on its surface.

Simple watercraft, the technological step beyond swimming, are a fixture in the history of the human experience. Dugout canoes, reed rafts, framed boats covered with bark or animal skins, and simple wood-plank boats exist in as many varied forms as the unique bodies of water they float on and the myriad tasks they have been built to accomplish. Be it carrying a passenger to a far shore, collecting fish on a flowing stream, navigating the swell of the ocean, or traveling great distances on a flowing river, simple craft of simple means have existed for millennia in cultures around the world. These simplest of boats all share a core concept: a buoyant craft, a paddler or group of paddlers, and their paddles, allowing people to travel where feet, wheels, or hooves will not carry them. There is a fundamental joy in conquering our natural inability to move across the waters'

surface, a joy that never gets old. Paddlers of these craft the world over connect in this wonder, and most cannot help but smile at the sight of any type of paddled craft drifting into shore at sunset, shooting down a rapid in flood, or charging through an ocean swell.

The draw of the simplicity and universality of the paddle, paddler, and boat is an important part of the story of canoeing as a sport. However, the more specific story of competitive canoeing and kayaking traces its history through the canoe's part in the foundational myth of modern North America. Understanding the story of canoeing necessitates an understanding of the canoe itself as part of the protracted, and fraught, process of cultural contact between North American indigenous people and the European settler society. The names *canoe* and *kayak* themselves reflect this Euro-centric mindset of "discovery" of these indigenous craft and their peoples, with the words we have today emerging through the process of European languages wrestling the indigenous names into European vernacular. Christopher Columbus is credited with first encountering the Haitian word *canaoua* as a name for the dugout-type canoes of the island of Hispaniola, and bringing the term into Spanish as *canoa*, which came to the English as *canoe*, while the Greenlandic Inuit word for "small boats of skins," *qayaq*, returned to Europe with the Danes as *kajak*, which became *kayak*.

From the earliest stages of cultural contact, the unique adaptation of indigenous paddle-driven craft to perform in the waters of North America was quickly obvious to those who were arriving from across the ocean. This was especially apparent on the inland waterways of the continent, where the major rivers, now known as the St. Lawrence, Ottawa, Hudson, Ohio, Mississippi, and Missouri, and their hundreds of smaller tributaries served as highways of canoe travel. It became clear to the European colonizers, explorers, and traders that adopting the light, repairable, and maneuverable canoes they learned to build and paddle from the Mi'kmaq, Wendat, Haudenosaunee, and others was the only efficient way to travel the expanses of the North American landmass.

The canoe became a critical feature in the life of any European looking to travel beyond the salty waters of their continent's shore, and indeed was a foundation in the process of exploration, expansion, and eventual domination of the North American landmass by European settlers. Canoes took Lewis and Clarke across the American continent and

carried David Thompson on his lifelong mission to map what is now the Canadian West. Meanwhile, for over 200 years the fur trade of beaver pelts, which was the backbone of the economy of British North America, operated using a variety of sizes of canoes and a vast network of routes. The Hudson's Bay Company, deeded by the British Crown to carry out this trade, and its eventual rival the North-West Company, used canoes to carry information, supplies, and furs across thousands of kilometers of rivers and lakes from present-day Montreal to the Rocky Mountains. For two centuries ending in the mid-1800s, being a professional paddler, or *voyageur*, was a viable career in New France and British North America for European, Aboriginal, and Métis men and women alike (Figure 1.1).

With this history and the mythology around it, the canoe holds heavy significance as a cultural marker for North America. The silhouette of the classic canoe, with its upturned stern and bow, is an iconic image associated with wilderness, exploration, and indigenous people. It is important to think critically about this significance and the cultural



Figure 1.1 A *canot du maître*, the large canoes used in the North American fur trade to travel major river routes.

place that the canoe holds not just for North America generally, but for Aboriginal peoples specifically. The mythology of the canoe can be a point of friction in the relationship between settler society and indigenous North American culture. There is no doubt that a debt of gratitude must be given for the gift of these ingenious North American boats to the world, and respect for the beauty reflected in their varied designs, refined for the landscape they were developed in through the ages.

By the late 1800s, the fur trade in North America was well past its prime. Rail lines stretched across the continent, and the highways of water were supplanted once and for all by these ribbons of steel. Along with Europe, North America was changing. The industrial revolution had fundamentally altered the economies on both sides of the Atlantic, and a new lifestyle awaited those who emerged through these changes as the middle class developed. With population shifts to cities, a wider distribution of wealth, more young people seeking education, and fewer hours needed for manual labor, the widespread concept of leisure time and recreation took off. Most major traditional sports we recognize today were born during this era. For the team sport and rule-minded athlete, baseball and football developed in North America while soccer (football) was rapidly gaining popularity in Europe. For those craving speed and modernity, there was the new sport of cycling. There was rowing, a mainstay at collegiate levels, and certainly the more technologically advanced of the water sports. Yet for those who sought to connect with water, but in a simpler craft, there was the sport of canoeing.

In America, where the mythology of the rugged paddlers of the era of exploration and the fur trade was strong, canoeing offered a connection to a nostalgic past. The living experience in cities like New York, Montreal, Ottawa, and Washington less and less resembled this conception of a wild and heroic past linked to generations gone by. Weekend trips to a lake or river to go canoeing became a popular chance to bridge the gap with the imagined past, feel authentically rugged, and enjoy the natural landscape increasingly distant from city life. Some sought out quiet lakes for sunset cruises, while others searched for the whirling rapids of the spring-time melt. New canoes based on those of the fur

trade and traditional Aboriginal designs, but updated for speed, whitewater, or comfort, were created using new materials and techniques, yet the core simplicity of boat, paddle, and paddler remained. For Europeans, canoeing was an activity that got them out of the city to float on country rivers, and the ponds of city parks. But it was also a chance to experience a piece of an “authentic” North American-style adventure, to feel a connection to the stories of the wilds of the continent across the ocean, and to re-create that imagined, idealized simple life of the Aboriginal peoples that they would read about in adventure novels. The style of boats being produced for purely recreational purposes in North America were brought to European waters, and they proved popular with the newly conceived figure of the weekend warrior who would flee the city on precious days off for some country air and a vigorous paddle.

On both sides of the ocean canoe clubs sprang up, founded by canoeing enthusiasts. These clubs were more than just boathouses in which to store canoes. By offering members access to boats, they provided the opportunity for a wider public to experience the sport, and out of this camaraderie the clubs became social hubs for their members during the summer months (Figures 1.2 and 1.3). These early clubs would be instrumental in the genesis of canoe racing we know today. In England, the first formal club was the Royal Canoe Club on the Thames, founded in 1866. It was home to the formative pioneer of canoe design, touring, and competition, John “Rob Roy” MacGregor. The first club in the United States, the New York Canoe Club, followed in 1870, and in Canada the earliest canoe club was built in this same period at the entrance to the Lachine Canal on the Island of Montreal. Soon, other clubs sprung up both in England and in Eastern North America, and before long the competitive spirit of these clubs’ members, and the pride in their home clubs’ colors, began to take effect. Races were organized, and over time competitive rivalries evolved. By the turn of the twentieth century, these clubs and early races had sparked formal national associations that went on to publish rule books, designate officials, and hold annual regattas. The sport of canoe and kayak racing as we know it today at the international level was born (Figure 1.4).