Longer and Deeper:

cross training for freediving and spearfishing

Jaap Verbaas
Author of Freedive Wire

To my wife, Gurveen for supporting me even while I was experimenting with a variety of training techniques that turned me red, white and purple; for never questioning some of my questionable diets and for freediving with me.

To our daughter, Nova, whose expected birthdate provided me with a firm deadline to finish this book. If she was born a few weeks later, it might have been finished on time.

Disclaimer

The material in this book is for informational purposes only. As each individual situation is unique, you should use proper discretion, in consultation with a health care practitioner, before undertaking the exercises and/or diet techniques described in this book. The author and publisher expressly disclaim responsibility for any adverse effects that may result from the use or application of the information in this book.

Jaap's note:

If an exercise doesn't make sense to you, don't try it. If you are unaware of the dangers of breath holds, take a freediving course. Consult a physician before doing anything in this book.

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Acknowledgements

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I would also like to thank Greg Elliot from G-Tech health in Vancouver. Greg aided in collecting the data I needed to really understand what goes on in our muscles (well, my muscles and theoretically yours too) during dry breath hold exercises.

Finally, my gratitude extends to the entire freediving and spearfishing community. For all the fun I've had since I started diving, for all I have learned, for the inspiration, and for being like a second family.

Foreword

"Jaap's book contains everything you need to know about training for freediving when you live away from the sea"

What do you do if you want to improve your freediving? You have to freedive. As a competitive freediver who lives far away from the sea, that is easier said than done. Most of my training is on land. I am a great example of one of the few freedivers in the world who prepares in the gym or at home before competitions. Another freediver who prepares on land is the well-known Guillaume Nery.

In the past two and a half years, I increased my CWT performance from 76m to 113m under the supervision of my coach Aharon Solomons. I emphasize safety and caution in all my training and diving. Nonetheless, many people think that this progression is very fast. Maybe even a bit too fast.

But there are no shortcuts. My performance is the expected result of systematic and effective training. Before going to the sea for depth adaptation, there are many things I need to work on. While many people struggle with themselves doing CO_2 tables, I work out with an upright bike and leg-press machine on empty lungs.

The result? A very delayed urge to breathe and great low-O_2 tolerance. I further work on relaxation and visualization to prepare my state of mind for diving. When I am doing a deep dive, my mind is actually in the gym. And when working out in the gym, my mind is in the sea.

Jaap's book is basically an encyclopedia of how to train yourself on land. And all the methods are backed by scientific theories. It is the ultimate training material you can have as a guideline on how to work out for freediving — for all levels of freedivers.

Aolin Wang
Chinese national freediving champion
Founder of Freefall freediving academy

Acronyms and important terms

In case you are not familiar with all the terms and acronyms I use, here is a small list to help you.

Aerobic – in the presence of free oxygen
Anaerobic – without free oxygen
ATP – Adenosine Tri-Phosphate is a high energy phosphate that is used by muscle cells to generate energy. The energy is stored in the phosphate bond and is released by changing adenosine tri-phosphate to adenosine di-phosphate.
Blood shift – An increase in blood volume in the thorax at the expense of blood within the limbs. Blood shift is a result of peripheral vasoconstriction and pressure, and limits the shrinking of the lungs during deep dives.
CNF – Constant No Fins. This is a discipline in freediving competition where freedivers try to achieve a certain depth without fins with constant ballast.
CP – Creatine Phosphate is a high energy phosphate that is able to "recharge" adenosine di-phosphate.
CWT – Constant Weight: a competitive discipline where freedivers try to achieve a certain depth with fins with constant ballast.
DNF – Dynamic No Fins: a competitive discipline where freedivers try to swim the greatest horizontal distance in the pool without fins.
DYN – Dynamic: as DNF but with fins
FIM – Free Immersion: a competitive discipline where freedivers try to achieve a certain depth by pulling themselves down and up along a rope.
FRC – Functional Residual Capacity: the volume of air present in the lungs after a passive (unforced)

exhale. This term is commonly misused by divers that dive on lung volume in between that of a full breath and a passive exhale.

High energy phosphates – The molecules that are used by muscle cells to generate energy in the form of muscle contraction. There are two types of high energy phosphates that will be discussed at length, ATP and CP.

HRV – Heart Rate Variability: the variability of the time in between heart beats. The changes between HRV from day to day are an indicator of physical and mental stress. HRV can be used to decide whether you need a day of rest.

Lactate – molecule that is formed during anaerobic exercise. A side effect of high lactate levels is an increase in muscle acidity. Lactate is often called lactic acid. Despite common belief, it is not responsible for muscle soreness.

MDR – Mammalian Diving Reflex, or Mammalian Diving Response. This is the physiological response to immersion in water and a lack of breathing, and includes lowering of the heart rate, peripheral vasoconstriction and splenic contraction.

Metabolism – the chemical processes that occur within the body to maintain life.

Metabolic pathway- a sequence of chemical reactions undergone by a compound in the body. We will mostly discuss metabolic pathways in the muscle fibres.

Reps – Repetitions: the amount of times an exercise is repeated without rest in between.

RHR – Resting Heart Rate: the heart rate at rest. The heart rate at rest can be used to decide on training intensity but is less reliable than HRV.

RV – Residual Volume: The lung volume after an active exhale.

Sets – A number of repetitions of an exercise followed by rest. For example, 1 set of 5 reps is 5 repetitions of an exercise followed by rest.

Vasoconstriction – The constriction of blood vessels to minimize blood flow. When the mammalian dive response is activated the blood vessels in the extremities constrict. Vasoconstriction is also caused by low CO_2 levels.

Vasodilation – The dilation of blood vessels. CO_2 and NO are both effective vasodilators.

Introduction

I started freediving in the Pacific northwest. The water is cold, murky, dark and quite uninviting. Because of the cold, we hardly ever spend more than about two hours diving per day.

With practice, my dives slowly became longer and deeper, but I also started getting colder and colder. Spending more time below the thermocline, where the water is about 6 °C year-round is a chilly affair. My suit compressed more and became less effective at depth. I became better at keeping still so generated less heat. I had to switch to a 5 mm suit instead of a 3 mm suit. I added a 3 mm shirt. I finally switched to an 8 mm suit. Unfortunately, all that neoprene makes diving incredibly difficult.

This is the vicious cycle of cold water diving. Every time you become a little better, and dive a bit longer and deeper, you become a little colder. To counter the cold, you get some more neoprene, and your dive becomes harder still.

The first time I dove in tropical water was in the Maldives in 2015. Most of the Maldives consists of tropical islands small enough to walk around in less than an hour, surrounded by an incredible underwater paradise. I could stay in the water for more than six hours per day. Never before had diving felt so easy.

If you dive all day long, you will become an amazing diver very quickly. Maldivians, Bahamians and other inhabitants of small tropical islands have an affinity for the water of which most freedivers can only dream. Some of them do not self-identify as freedivers but will happily spend hours

snorkeling and diving in the 5 – 15 m range.

Not all of us have the luck of living on a tropical island surrounded by steep reefs and warm waters. Freediving is a sport practised by people all over the world. For most it is a hobby, for some a way of living, and for others a competitive sport. You can experience the joy of being one with the ocean no matter where you live. It's just a little harder in some places.

The best training for freediving is freediving, and the best training for spearfishing is spearfishing. Unfortunately, most of you can't be in the water all day. Perhaps the ocean conditions do not allow you to dive for more than an hour or two at a time like here in Vancouver, or perhaps you are simply too busy.

Cross training is training in different disciplines to improve in the main discipline. If you are unable to spend a significant amount of time in the water, you likely have already resorted to cross training in the form of static tables or pool training. It is no surprise that most divers are interested in ways to train their bodies to better adapt to the underwater world. Freedivers and spearfishers want to dive longer and deeper, and they want to be safe and comfortable while doing so.

If you enjoy the ocean and want to know what you need to do in the gym to become better at the freediving and spearfishing, this book is for you. Whether you dive in the 5 – 15 m range, or the 25 – 65 m range, this guide presents useful exercises to help you stay fit while the seasons keep you out of the ocean.

You will learn:

- Whether a particular training method will to help you freedive, and how
- Whether those CO_2 tables really help
- How to dive deeper and longer, even without being able to be in the ocean
- How train specifically for freediving and spearfishing
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This book is divided in four parts.

In part one you will learn the principles of cross training. You will learn about training intensity, so you know when to push hard or when to take a step back. You will learn how to record your training, so you identify when a workout has a positive effect or not. You will also learn about the limitations of cross training for freediving.

In part two you will discover how the body stores oxygen, where the body stores oxygen, and how it is used during a dive. You will then understand how you metabolize energy and specifically how the muscles work. This part is written for those of you who want to comprehend the science behind freediving. I recommend you read this section if you want to tweak the exercises to your specific needs. If you don't care too much about the detailed background, just skip this part and go straight to the exercises.

In part three we will get into the specific exercises that you can do to get into shape and stay in shape. You will learn exercises you can do in the gym, on the couch, on a yoga mat, and on running trails.

In part four you will discover how to schedule your training. Besides learning how to schedule your training for maximum performance, you will learn how to design a training schedule that you can actually maintain.

Whether you want to reach a new personal best, to spearfish and forage deeper, or for pure enjoyment, this cross-training manual will help you to adapt your body to the underwater world.

Your body during a perfect dive

The descent

After your breathe-up, your mind is calm and you are ready for your target, whether it is a big fish or a specific depth. You take your final breath and start to descend. A perfect duck dive takes you straight down into the deep blue. You kick strongly in the first few meters to overcome positive buoyancy. This buoyancy is mainly the result of the nitrogen in the neoprene of your suit and the air in your lungs. Your power output is the largest at the start of a dive, because the positive buoyancy force at the surface is larger than the negative buoyancy force at depth. In other words, if you are properly weighted you float more at the surface than you sink at depth.

You use energy stored in your muscles as high energy phosphates for the first kicks. These high energy phosphates are the perfect energy reservoir for the first kicks of your dives because they can be used without using O_2 and without producing CO_2 or lactate. Now your months of preparation pay off. Because you have trained your "phosphate battery" you are able to overcome positive buoyancy and enter the sink phase without using much O_2 and without producing much CO_2.

If you want to train for the perfect descent, you need to focus on increasing the reservoir of high energy phosphates. This is also called the ATP-CP system. (see p. 29 & p.90).

The sink phase

You have reached negative buoyancy and start sinking. You make sure you are completely relaxed. The dive response becomes strong and your arms and legs are vasoconstricted. Your heart rate is lower than usual. Even though you are consuming oxygen during the sink phase, the increased pressure allows your blood to be fully saturated with oxygen.

The increased pressure at depth causes more CO_2 to dissolve in your blood. Because you have trained your tolerance to CO_2, you do not get an urge to breath during the sink phase.

The pressure also causes your lungs to shrink below their residual volume. Since you have incorporated stretches and relaxation exercises in your training program you are not at risk of trachea or lung squeezes.

If you want to train for the perfect sink phase you need to focus on increasing CO_2 tolerance, relaxation, reducing drag and stretching.

The ascent

You turn and start to make your way to the surface. There is still blood flow to your muscles but because of the vasoconstriction and blood shift, it is minimal. The blood cannot deliver enough oxygen to the muscles for the entire ascent. Because of your training program, your blood contains more oxygen. Even the reduced blood flow still delivers more oxygen than it would before your training.

When the muscles cannot extract enough oxygen from the blood to power the muscles, they start to extract oxygen from a compound called myoglobin. Myoglobin is a protein in muscle cells that carries oxygen from the blood to the energy factories in the cells. Because of your training, you have a significant amount of myoglobin in the muscles and your legs do not feel tired until late during the ascent.

Once both the blood and myoglobin in the muscles have released their oxygen to the muscles you start to produce lactate. Your muscles are now completely deprived of oxygen and your legs start to feel tired.

You know that most blackouts happen near the surface because of the fast change in pressure. You increase your speed to make sure that you surface quickly but calmly. You reach the surface and, after a few breaths, know that you did not become very hypoxic. You know how to assess this because of your training with an oximeter. You give your dive buddy a clear OK signal and, after your recovery breathing, you are good to prepare for another dive.

If you want to train for the ascent, you need to train the muscles to perform in the presence of high concentrations of lactate.

Your body during a bad dive

The descent

You have done your breathe-up and take your final breath before your dive. You hold some tension in your muscles because you have had a busy day. You tell yourself it does not matter, you can do this depth. Your duck dive is a bit off and you need to correct it so that you swim vertically, wasting energy and oxygen. Because you have not trained much, your muscles do not contain enough energy to bring you down to neutral buoyancy and you waste some O_2 and produce some CO_2. Your legs already feel slightly tired before you start sinking.

The sink phase

The tension you retain in your body does not allow you to relax completely in the sink phase. Your diaphragm does not flex up as it should, and your lungs and trachea experience unnecessary negative pressure. You realize that you are feeling uncomfortable well before the bottom plate and your diaphragm starts to flutter. Contractions of your diaphragm have not started yet but you can feel them coming. The CO_2 produced during the descent now causes an urge to breathe.

You start to experience strong contractions but you are close to your target so you decide to keep going. Because you are uncomfortable and you know you are close, you look at your target, even though you know you should keep your chin tucked in. Your trachea lengthens which causes even more negative pressure in it, and in your lungs.

The ascent

You make a sloppy turn and start finning back to the surface. Your legs instantly feel very tired and your kicks are far from optimal. A voice in the back of your mind says you are not finning properly but you are in a rush and do not correct it.

You notice more light now and know your safety divers will come down soon. Your legs are exhausted and your safety diver looks funny. You try to focus on the line. The dive feels easier now and you keep finning up. You see bubbles around you but don't realize they are yours.

Most blackouts occur at or near the surface. The reason is that the pressure rapidly declines near the surface. At depth, the pressure of the water helps to keep your brain and body oxygenated. This effect quickly diminishes from 10m depth to the surface.

The next thing you realize, you are at the surface of the water. Your safety diver looks worried but you hardly notice him. Your vision has a reddish black hue to it and something feels funny in the back of your throat and lungs. You start coughing up blood. Slowly you regain consciousness after your black out. You realize you suffered a squeeze at depth and will have to take some time off.

The real purpose of this book

I hope you will be spared a bad dive like the one just described. If you have had such an experience, it may have come after a period of not diving because you did not

realize you lacked training. Or perhaps you simply did not do a proper warmup, or maybe you cannot pinpoint a cause?

What I aim to achieve here is to turn your bad dives into perfect dives. Rather than coming up with a lung and trachea squeeze and blacking out near the surface, you should come up calm and rejuvenated. Although this manual does not cover everything there is to learn in the water, the exercises are designed to make you more comfortable within safe limits.

I also hope you will learn more about the theory behind breath holding and muscle performance during breath holds. By learning about different type of muscle fibre and how to train them, you might also understand what your natural body type is, and perhaps how to best leverage your strengths in the water.

Additionally, this book gives you specific exercises you can do at home and in the gym. All exercises can be done strenuously or lightly and are meant for the beginner to intermediate freediver and spearfisher. If you are an expert freediver you probably have already found a set of exercises that work for you. Even so, I hope you will be able to use the theoretical ideas and exercises in this book to your advantage.

Naturally, if you track your training well, you will be able to assess your level of training before each diving session. You can record all your training in a training journal. Over time this will provide you with valuable insight into how specific exercises help you dive.