# OPEN WATER & TRIATHLON SWIMMING

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A CIP catalogue record for this book is available from the British Library.

Printed by: Peach Print Limited
Impressions House, 3-7 Mowlem Street, London E2 9HE

Published by P2P Publishing Ltd

Registered office: 33-41 Dallington, London, EC1V 0BB
Tel: 0845 450 6402 Registered number: 06014651

ISBN: 978-1-905096-55-8

**Publisher** Jonathan A. Pye
**Editor** Andrew Hamilton
**Designer** Lorraine Gourlay

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# LETTER FROM THE EDITOR

**Open water and triathlon swimming**

Swimming is undoubtedly one the greatest all-round sports, providing truly superb conditioning. But while the indoor pool provides a consistent, safe and controlled environment, there's another dimension to this sport that remains unexplored by many swimmers.

Originally the preserve of triathletes, open water swimming as a sport and supplementary training method is becoming popular in its own right and it's easy to understand why. Swimming in open water is not only great for developing physical and mental toughness; the open water environment also provides a fantastic challenge and a real 'connection' with the natural elements, which is so often missing in today's high-tech world.

In this special report, we look at how swimmers and triathletes can use open water swim training to maximise both indoor and outdoor swimming fitness for any event and prepare for a major open water event. There's also extensive new research into how swimmers can prepare themselves mentally for the unique challenges that open water swimming provides as well as invaluable advice on health and safety.

Whatever kind of swimming you do, this report contains the information that will help you reach new levels of physical and mental toughness and lift your performance to new heights!

**Andrew Hamilton BSc Hon MRSC ACSM**

# THE LURE OF OPEN WATER SWIMMING

**At a glance**

Andrew Hamilton explains the lure of open water swimming and gives some basic guidelines for swimmers looking to escape the pool!

On the face of it, swimming as a sport is not exactly associated with the great outdoors. Other than a trip to the seaside and a quick paddle in the sea along with an ice cream, the closest most swimmers (other than hardcore triathletes) get to the outdoors in swimming is on the way to the pool!

This is hardly surprising really. For starters, long lazy days on the beach are seldom appealing for those living more than 40 degrees north or south of the equator. And even in northwest Europe, which is bathed in the temperate waters of the Gulf Stream, a mean sea temperature of around 12 degrees C is still chilly enough to bring tears to the eyes of even the hardiest souls!

However, no matter how warm and cosy your local pool is, there's still something missing. Even putting aside the hassles of the chlorinated pool water, the problems of finding enough room in a lane to swim uninterrupted and the limited opening hours, pool swimming can be, well frankly mind-numbingly boring.

If you've ever had a yearning to escape the confines of the 'concrete box' and swim across some real open water, there's good news. Thousands of competitive swimmers are already doing it and loving it. Quite apart from adding a new and adventurous dimension to their swimming, they've also discovered that open water swimming is a great way of building greater pool swimming fitness and mental toughness.

## What is it?

At the risk of stating the obvious, open water swimming takes place almost anywhere other than a pool. Apart from the sea, lakes, reservoirs and even rivers can provide you with open water swimming opportunities. Although many people assume that open water swimming necessarily entails swimming huge distances as exemplified in that first famous swim by Captain Matthew Webb, the first man to cross the English Channel back in 1875, the reality is that it's up to you how long and far you swim.

Many swimmers though do end up getting hooked on the open water and turn to competitive racing, which may entail distances of up to 25 kilometres and durations of several hours (see the article on Julie Bradshaw elsewhere in this report). However, the real difference between open water swimming and pool swimming is the experience itself. Quite apart from the sense of freedom and the chance to enjoy your surroundings in open water swimming, you can really get into a good stroke rhythm. There are no brick walls every 25 or 50m to break your stroke pattern and unless you're in a race, no bodies on your way. It's just you and the water below you.

## The unknown

There's something else that marks out open water swimming. Humans are land creatures who have managed to master our terrestrial environment. But when you swim in the lakes or the sea, you have to leave the cosy world of human control behind and come face to face with the raw elements. It doesn't matter how strong or how fast you are in the pool, swimming across open water is a whole new ball game. There are a number of things you'll need to contend with:

- **Deep water –** there's no blue line at the bottom of a lake of the sea. Even top open water swimmers can sometimes feel spooked by the thought of tens or even hundreds of feet of deep, inky black water below them while they swim.
- **Cold water –** unless you live in the tropics, you're going to have to deal with this one. The good news is that modern wetsuits have made cold water swimming possible for even the leanest athletes, but it can still come as a shock to feel that

water on your face, hands and feet for the those first few minutes of the swim, while you acclimatise.

- **Other objects** – was that a bit of seaweed, a fish or something with much bigger jaws that just brushed underneath me? On those inevitable occasions when you do feel find you're not alone in the water, you need to keep your nerve. Jellyfish are a common nuisance for sea-swimmers, especially when they sting the face and an occasional shark sighting can certainly add excitement to your workout!
- **Waves** – when wind blows across water, it produces lumps, more commonly known as waves. Although you may think your pool gets a bit choppy, swimming through real waves is something else. You have to be prepared to modify your stroke and breathing to cope with the rougher stuff. And even if you do, you'll find the next problem is...
- **Navigation** – this is when you actually begin to miss those blue lines. Getting only occasional glimpses of landmarks or marker buoys makes navigation difficult, especially when viewed from such a low angle. If you're in the sea you may find that between two waves you see nothing other than walls of water piled up around you. You need to also be aware of the effect of currents, which can throw your navigation off course.

The reality is that anything can happen out there on that big wide expanse of water, so you'll need both swimming fitness and mental bottle. But for many, it's precisely this challenge of facing and conquering the unknown that is the real raison d'etre of open water swimming.

## Safety for beginners

If you're new to open water swimming, it makes sense to think about both your own safety and that of others before you take the plunge. This is particularly the case if you're going to be swimming in open water away from an organised or supervised environment, such as a race or a beach patrolled by lifeguards. Even if there are others around, don't go into the water with the attitude that you can depend upon someone else to bail you

## Box 1: Safety tips for open water swimmers

- **Don't swim alone** – if you can, swim where there are beach lifeguards around or with someone else who is also a competent and proficient swimmer. If you can both life save, so much the better. In cold conditions, even the best swimmers can experience unexpected stitch or cramps.
- **Be visible** – wear the brightest swimming cap you can. It'll not only help others to see you should you get into trouble, but make you more visible to any boats or jet skis in the area.
- **Tell others** – if there's anyone on the shore, tell him or her what your swimming plans are.
- **Obey instructions** – if you're swimming in a patrolled area or in an event, don't ignore any safety advice. In particular, you need to be aware of any potentially dangerous underwater obstacles such as sharp rocks or old wrecks, and the whereabouts of riptides or strong offshore currents that could throw out your navigation.
- **Seek advice** – if you're swimming in an unfamiliar stretch of water, seek advice about the venue and the best swimming areas, especially any underwater hazards or currents. Check that the water quality is suitable. The last thing you want is to end up with an eye infection or a stomach upset.
- **Never dive in to unfamiliar water** – you may get a nasty surprise when the rocks just below the surface smash into your skull.
- **Swim parallel to the shore** – assuming there are no hazards (above), always swim parallel to the shore. If you get into trouble, you can more easily get back to safety than if you simply swim out to sea or to the middle of the lake. If you're doing a point-to-point swim, try to choose two points that will keep you close in to the shore.
- **Food and drink** – never swim within 2 hours of a meal. Never swim after even the smallest amount of alcohol.
- **Watch the weather** – don't try and swim in really rough sea conditions, no matter how tough you think you are. Quite apart from entering and leaving the water, where it only takes one wave to pick you up and smash you down on the sea floor, you'll find it extremely difficult to breath and navigate when the water is very choppy. Never swim in foggy conditions – not only will you lose your bearings when the shore disappears from view, but you will also not be visible to others.
- **Keep warm** – cold water takes it toll on the body quickly – make sure you have a wetsuit for cold water and that it's suited to the conditions (see kit).

out. Needless to say, open water swimming is NOT recommended unless you already have good swimming fitness and technique in the pool as an absolute minimum. If you have any doubts about your ability, competence or confidence you should think twice – it's just not worth risking your life. Box 1 opposite gives general safety tips for open water swimmers.

## Techniques

**Stroke and breathing –** In totally calm conditions, there's not much difference in swimming technique between open water and pool workouts. Of course, from time to time you'll have to hold your head up and snatch a quick look to get your bearings and help you navigate but that's about it. To begin with, you'll be tempted to do this every few strokes as you set out into the unknown. But you soon realise that lifting your head wastes a lot of energy by ruining your streamlined position(1) and as your confidence grows, you'll get used to looking less frequently.

Once the water gets choppy, which is almost always, you'll need to modify your stroke and breathing techniques. The choppier the conditions, the higher you'll need to lift your arms out of the water in between strokes otherwise you'll find your arms will get knocked all over the place, which will make the next stroke that much harder to execute. Get the hand out of the water and get it high quickly.

Breathing in choppy water is a real skill and no matter how good you become, you'll have to be prepared to swallow the odd mouthful of water from time to time. Most swimmers prefer to turn their head to the opposite side of the direction of the oncoming wind and waves because that way you get some shelter. This is a good reason to practice bilateral breathing. After all if you can only breath to the right and the wind's coming from the right, you've got problems!

**Waves –** Sea-swimmers have to contend with proper waves. Once you're out to sea, big waves don't really affect your swimming other than the weird sensation you get of falling and rising as they pass underneath you. The real problem lies in getting from the shore out beyond the breakers. For some it's an exhilarating challenge – for others it's terrifying. The most useful thing to remember is to present as little surface area as you can to the oncoming wave and avoid trying to swim through the white water that results after it breaks. In reality this means that once you're at waist level or deeper, you're best to duck-dive through and underneath the wall of the wave as it approaches you, rather than try and negotiate it as it breaks. Keep relaxed and accept that you'll inevitably be tossed around a bit as you progress out through the surf. Remember that you may have to repeat this process more than once if there are several breaking waves coming toward you in which case you'll need to make sure you can come up for a really good gulp of air in between waves. In very shallow water, you can leap over the waves.

The other thing you'll need to think about is getting back to the shore after your swim. This is much easier than leaving the shore, because you can use the momentum of the water to help you in. The best technique is to catch the top of the wave as it begins to break and bodysurf back in. Beware though of leaving (or entering) rough water on a steeply shelving beach. Here the waves can crash downwards with tremendous force, otherwise known as shore break. Shore break occurs at high tide when heavy surf conditions cause large waves to break on the beach with little or no water under them and can be particularly dangerous to a swimmer who is caught in such a wave because the wave can slam the swimmer on the beach, causing injury. Shore break is the most frequent cause of serious back, neck and shoulder injuries at the beach(2) – you shouldn't body surf during shore break conditions.

**Currents –** If you're swimming with a current, you'll cover distance very much more quickly than against. For safety reasons then, it makes sense on an out and back swim to always swim against the current on the way out and with on the return. Most currents though are not exactly with or against your swimming direction, but include a cross component. Here you have to aim 'upstream' of the current, because while most of your effort will be spent getting from A to B, some will be spent overcoming the current. For example if the current is coming from your left as you swim, you need to aim for a point to the left of your actual destination. Just keep checking your position as you swim, making adjustments where necessary and remembering that the current may not be constant in direction or speed as you move towards your destination.

## Kit

The most important bit of kit you'll need is a wetsuit. Wetsuits work by trapping a thin layer of water in between you and the neoprene material from which they're constructed. Your body quickly warms up this water, which then acts as an insulating layer and keeps you warm when immersed in cold water. The colder the water, the thicker the neoprene panels of the suit should be. A fitted wetsuit should be snug to the point of being tight and shouldn't have loose or baggy areas because these will allow fresh cold water to flow in and displace the warm insulating layer of water. Check particularly the fit around the neck and hip area.

Wetsuits suitable for swimming in (as opposed to general water sports) incorporate a very flexible and stretchy grade of neoprene under and around the shoulders. This is to allow as much freedom of movement as possible in the swimming action. If you want a wetsuit that is both very warm and gives real freedom of movement, you're best bet is to have something tailor made for your particular body shape. Good wet suits aren't cheap, but it's money well spent, allowing you to swim in waters that would otherwise be simply too cold. Other than a wetsuit, you'll need well-fitting goggles, especially in salty seawater. If you're doing long swims in sunny conditions, you may want to invest in goggles that filter out UV rays. As we've already mentioned a brightly coloured hat is also essential. If the water is really cold, you can even wear two caps – one under the other. Finally, don't forget to take plenty of warm dry clothing for before and especially after your swim. You'll be surprised at how much heat you can lose getting out of that wetsuit. It's also worthwhile keeping a couple of blankets to hand and taking a flask of hot drink, especially in wintry conditions!

### When should I swim?

Because water takes longer to heat up and cool down than air, the temperature of large bodies of water such as the sea and lakes tends to lag behind the air temperature. This means that in the Northern Hemisphere, the sea is warmest two months AFTER the summer solstice, around the end of August/ early September and coldest around the end of February/early March. These peaks are of course reversed in the southern hemisphere. There's also a smaller daily temperature, more noticeable in shallower water, especially on sunny days. Late afternoon is the time to swim if you want the warmest water of the day – first thing in the morning if you like it cool. However you won't notice this effect in deeper water or in the sea, unless you're swimming in a shallow bay.

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**At a glance**

- The physiological and psychological demands of Channel swimming are analysed;
- Systematic training strategies are presented to help long-distance open-water swimmers to develop mental and physical toughness, set goals and manage their emotions.

**Long-distance open-water swimming requires extraordinary physical and mental toughness. Andy Lane and Greg Whyte (who recently helped the British actor David Walliams to succeed in his first attempt to swim the English Channel) explain the psychology and physiology of preparing for a long-distance open-water swim**

Imagine the scene; it is 5 o'clock in the morning and you're about to walk into the sea at Dover with the intention of swimming the English Channel. You will be swimming in a dark, cold and lonely environment. Not surprisingly, the prospect of performing in such conditions makes you ask yourself questions such as: Why am I doing this? Will I be able to keep going?

## Establishing the goal and developing a plan

Distance swimming events are not something to be entered into casually, or at the last minute. They tend to be events that athletes need to commit to a long time in advance. It is important not to enter such events without giving due consideration to the difficulties of the task.

Following David Walliams' successful Channel swim, several celebrities have speculated about swimming the Channel themselves. While such desires can be praiseworthy, in many instances they display a gross underestimation of the difficulty of the task. For example, a number of swimmers have died trying to swim the English Channel, and with a success rate below 40%, thousands of others have failed.

Walliams' success seems to have engendered a message to such people: 'If he can do it so can I.' Many people identify Walliams as a comedian on the show *Little Britain* rather than an elite endurance athlete, and have therefore concluded that swimming the Channel must be achievable. However, distance swimming requires physical and mental toughness and this article focuses on how to prepare for such a challenge.

Having set the goal of swimming the Channel, it's worth reflecting on why you want to achieve it and how much it means (*see table 1*). Get out a piece of paper and on one side write down the reasons why you want to achieve the goal. On the other side, list what the barriers to attaining this goal are likely to be.

Unless a swimmer has attempted to swim the Channel before, he or she will not know the magnitude of the challenge. Identifying barriers to goal completion is difficult, as they can only guess how hard the challenge will be. They tend to have an idea of how hard they are prepared to push themselves, but do not know whether they will be able step up to the challenge. The training programme should therefore reflect the physiological and psychological demands that are needed.

**Table1: Planning goal achievement**

| **Goal – to swim the Channel** | |
|---|---|
| **Reason for involvement** | **Barriers for goal achievement** |
| Achieve an important personal goal | Will find it difficult to find time to train; especially during busy periods at work |
| Be able to push myself harder than I thought | Times when I do not feel like training and when I want to do the 'hard' training on a different day |
| Enjoy swimming | Days when I start training and feel extremely tired from the outset |

## Training demands

Training for open-water swimming performance should focus on two key areas: physiological performance and open-water experience and habituation. Open-water swimming is now part of the Olympic programme, and races over 10km were contested for the first time at the 2008 Beijing Olympics. In the main, open-water swimming events are endurance and ultra-endurance in nature with durations ranging from 1 hour up to about 15 hours. Accordingly training is dependent upon the race distance, but the underlying determinants are primarily endurance based.

A significant factor in open-water swimming is 'experience and habituation' (this term is preferred over 'acclimatisation' as very little acclimatisation takes place in response to cold-water exposure) to open water. Most open-water swimming events are in cold (<18°C) water resulting in significant cold-induced stress.

The human body needs to control its core body temperature within narrow limits to maintain normal function and survival. Maintaining core temperature is achieved through a balance of heat production (a by-product of energy production) and heat loss. Water is 25-times more conductive than air leading to a 4-fold increase in heat loss for anybody immersed in it. In open cold water, heat production becomes essential in maintaining normal function.

At rest the energy expenditure (and therefore heat output) of the human body is about 100 watts rising 15-fold to 1,500 watts during exercise. Thus, a high-energy turnover and power output (speed) must be maintained to sustain core temperature.

In addition to core temperature, peripheral and skin temperatures play an important role in open-water performance. When cooled, peripheral nerve conduction velocity falls by $15ms^{-1}$ for every 10°C and muscle power output falls 3% for every 1°C fall in muscle temperature, thus reinforcing the need for maintenance of power output to reduce the deleterious impact of cold on performance[1]. A cold shock response can occur immediately on submersion in cold water leading to hyperventilation and a dramatic fall in breath hold time (the leading cause of drowning)[2].

Although there are limited adaptations to cold water, acclimatisation (habituation) can reduce the cold shock response. Other factors associated with open-water swimming include the hypertonic environment of seawater with a 3.5% sodium solution compared with 1% in cells. This hyper-saline environment leads to significant problems with feeding and abrasions that can have a profound effect on performance.

Habituation (experience) is fundamental for the successful open-water swimmer. In addition to coping with the physiological impact of the cold and sometimes saline environment, the ability to navigate, control and maintain pace while coping with the prolonged isolation of often opaque, deep water with the fear of wildlife below makes open-water swimming a significant physiological and psychological challenge.

## Short- and long-term goals

Once the programme has been developed it is important to see how the short-term goals link to achieving long-term goals. Swimming the Channel involves completing about 40,000 strokes. It is important to develop a mindset in which goal attainment is seen as the product of achieving minor goals.

A key question the swimmer should pose themselves during moments of difficulty is: Can I swim one more stroke? The answer will almost always be a definite 'Yes'. It is worth exploring why the swimmer believes this is achievable. At the point when a person decides to stop such a challenge, a key question to ask is: What thoughts and feelings were experienced at the time?

Unpacking these decisions can provide insight into how to develop a greater sense of reliance in being able to cope with extreme fatigue in extreme conditions. Underpinning achieving the goal of swimming a long distance is the attitude that it is achieved by swimming one stroke at a time. Once the swimmer has accepted that goal attainment is achieved by swimming one stroke at a time, extending swims from one hour to two hours is not so difficult.

## Managing the experience

Long-distance swimmers need to be confident that they can manage swimming in cold open water. Research shows that athletes experience considerable mood fluctuations during long duration-intense exercise[(3)]. A long-distance swimmer can expect to experience waves of fatigue. Fatigue can be accompanied by other emotional states such as anger and anxiety, or fatigue can be accompanied by feelings of satisfaction.

In cases where athletes experience a range of debilitating emotional states such as fatigue, anger and sadness, this tends to be accompanied by both negative self-talk and negative images. It is important to recognise that these emotional states are transient, and if the athlete can use strategies to change these emotions from negative to positive or to neutral, the accompanying self-talk and images tend to become positive[(4)].

However, it is how the athletes learn to cope with these feelings that is important. Developing data on emotional and cognitive changes experienced during hard exercise is the starting point for intervention work. This can be done retrospectively by asking athletes how they felt during certain parts of an event and what type of things were they saying to themselves when experiencing these emotions.

Distance swimmers should be encouraged to challenge the link between emotions and self-talk and question whether it is possible to interpret their fatigue without the accompanying unpleasant emotions. Evidence shows that when an athlete feels fatigued, this could be interpreted as indicative of goal achievement drawing closer. In such a scenario fatigue is likely to be accompanied by excitement and joy. In addition, athletes can experience fatigue and happiness simultaneously when achieving a challenging goal such as completing a marathon[(5)]. Strategies designed to improve self-talk have been found to

**Box 1: If-then rules**

- Explore potential parts of the events where negative image and thoughts can creep in. Record this information.
- Develop desirable alternative scenarios for negative events.
- Make if-then rules for each scenario.
- Repeat each if-then rule in the morning and then again before training.
- Record in your training diary the effects of if-then rules on coping with stress.

**Table 2: Examples of the application of if-then rules in open-water distance swimming**

| IF | THEN |
|---|---|
| I feel cold | I must concentrate on my technique and use self-talk to change thinking towards warmth until these feelings pass |
| I start to think that if I feel like this after five hours I will never make it | I will dissociate with swimming for a while by humming the tune of selected songs |
| I start to feel sick and start to vomit | I will inform my support crew and allow them to make the appropriate choice of intervention *ie* mouthwash, for the next feeding stop |
| I start to get stiff | I will run through my stretching routine at the next feeding top and alter my stroke to offset the stiffness |
| I start to think about how long I have been going | I will shift my thoughts to pre-planned approaches to move my thoughts from time *ie* running through favourite films |
| I start to think that I will not be able to get into shore, having been able to see the coast for hours | I will focus on swimming, reinforcing the message to continue putting one arm in front of the other |
| I start to concern myself about what lies beneath me in the opaque water below | I will reassure myself that there is nothing to fear and reinforce the positive elements of prior experience |
| I start to doubt my ability to cope with the cold, or the distance or the environment | I will use positive self-talk drawing on my training and experience to reinforce my proven ability to cope with the challenge |

effectively cope with performance-related stress.

Recent research suggests that using 'if-then' rules can be an effective strategy for emotion management[6]. If-then rules work by replacing undesirable thoughts with positive emotions (*see box 1 and table 2*). An effective strategy in swimming is to develop the mindset that goal completion is achieved one stroke at a time. Focusing on technique can be an effective strategy to disassociate with fatigue.

A second strategy is listening to music[7]. Synchronising with the rhythm can be helpful and engaging with the lyrics can enhance motivation. Swimmers can simulate listening to music by humming songs.

Some athletes prefer to focus on external factors – for example what they will be doing in a week's time. However, strategies that try to disassociate completely with the task at hand can be demotivating and lead to further increases in unpleasant emotions. When an athlete starts thinking about doing more desirable things, this can lead to questioning why he/she is engaging in such a difficult challenge.

## Preparation for the event

It is easy to be daunted by the prospect of having to spend over 10 hours swimming in cold, dirty and choppy water. The event needs to be broken down into small manageable chunks. While this approach to goal setting has been well voiced, relatively less attention has focused on managing the expected thoughts and emotions that will be experienced at key points during the performance.

Preparing to manage these experiences should be considered carefully. In addition to using 'if-then rules', imagery scripts should be developed in which the swimmer re-enacts coping successfully with difficult phases of the event. Imagery needs to be based in the experiences of the swimmer. This is why it is crucially important to have experiences that are similar to those that will be experienced in the event.

The most challenging experience to replicate is coping with excessive fatigue. It is possible to construct a practice to replicate coping with it, but this needs careful management of psychological and physiological responses. However, it's very important to get the swimmer to buy in to the value of this approach and swimmers need to see this type of training session as an opportunity for psychological and physical preparation.

Repeated bouts of hard training can deplete physiological resources, leading to a persistent state of fatigue[5]. We argue that an athlete's beliefs on the influence of fatigue on performance and wellbeing are highly important in the development of adaptive responses to repeated bouts of hard training. Athletes need to accept that they will experience intense feelings of tiredness following hard exercise. However, difficulties start arising when an athlete feels that they underperformed during training. Feeling downhearted because you believe that you've underperformed during training can exacerbate feelings of fatigue. This will lead to a downward spiral of negative mood and poor performance.

Replicating the most difficult part of the event will require getting the individual into a highly fatigued state and asking them to produce a high-quality performance. There are several different ways to induce a highly fatigued state; back-to-back hard training sessions, inadequate nutrition, and poor sleep strategies have all been used. Once in this fatigued state, the athlete should spend more time than usual mentally preparing before the session starts. Although mental preparation should be a part of every session, this is an opportunity to further enhance beliefs that he/she has the ability to cope with extreme fatigue in environmentally challenging conditions.

Adopting training approaches that use multiple episodes of training leading to high levels of fatigue are valuable in replicating both the physiological and psychological stresses associated with open-water swimming. Using multiple sessions in a single day and prolonged sessions on consecutive days are common practices in open-water swimming.

Classical preparatory sessions for English Channel swimmers include six to seven hour swims on consecutive days. By adopting this type of approach, the swimmers can develop proactive strategies for dealing with the challenges detailed above, in both a non-fatigued and a fatigued state. Furthermore, replicating start times that are often in the dark and preparing to finish in the dark assist in preparing the swimmer for worst-case scenarios, as are developing coping strategies for those eventualities. Effective preparation involves maximising the use of the full range of likely experiences.

### Practical implications

- Both physical and psychological preparation are essential for attemping a marathon swim such as the Channel crossing and swimmers should not neglect one at the expense of the other;
- It's inevitable that swimmers will experience emothional peaks and troughs during long swims. In order to prepare an emotional coping strategy, training sessions that create high levels of fatigue should be included.

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# LAND-BASED TRAINING FOR SWIMMING TOUGHNESS

**At a glance**

- The importance of the 'transfer of training' effect is discussed for swimming conditioning programmes;
- Four basic exercises for developing explosive strength and power in swimmers are described;
- The principles of combining strength exercises into a coherent programme are outlined.

**In the quest for performance, swimmers typically cover thousands of metres with nothing more interesting to do than look at the bottom of the pool or horizon. But according to Nick Grantham, a properly designed land-based strength and conditioning programme is essential too, and simple circuits on the poolside are not enough.**

Land work for swimmers is becoming increasingly popular, although it is by no means a new concept. Researchers and swim coaches have been expounding the virtues of 'land-based' training since the late 1970s[1-6] However, many 'land-based' training programmes that I come across simply don't hit the mark when it comes producing a really positive impact on performance.

Most coaches pay lip service to strength training by simply 'bolting on' a circuit session at the end of one of their pool sessions. Although well intentioned, they try and cover everything from injury prevention and rehab through to power development in one 30-minute training session a week. This is better than nothing and can be a good starting point. However, the purpose of this article is to provide you with an overview of some of the key strength and power development strategies that coaches and swimmers can implement to get maximum bang for their buck.

## Sport-specific vs transfer of training effect

Before we discuss the areas that can have the largest impact on swim performance, we need to clear a couple of points up. Sport-specific work is the best way to get better at that sport; if you want to be a better swimmer, then swim! But how can you make additional gains when you have maximised your swim time? One way is to add 'land-based' training. However, the big problem is that coaches often fall into the trap of being 'sport specific' when designing their strength training programmes.

The main problem with developing exercises that are really sport specific is that you may be in danger of harming the one thing that you want to improve – swimming technique and performance. For example, an ambitious young coach that I once worked with had developed some sport-specific drills replicating the swim strokes in the gym – so much so that he even set a metronome to the exact stroke rate used by the swimmer in the pool to perform each repetition of the strength exercise!

But by getting so close to the actual movement pattern in the gym, you may actually start to interfere with the neural patterns being laid down during swim training and actually make the swim stroke worse. If you want swim-specific strength therefore, do it in the pool. Research supports the use of resistance devices in the pool such as the use of a tether, or rope with a sponge attached, *etc*[7]. But just lying on a bench in a gym trying to replicate your freestyle stroke to the sound of a metronome is wasting time and effort. What you should actually be thinking about is the 'transfer of training effect' – *ie* what exercises can I perform that will have transfer over to improved performance in the pool?

## Where can the strength coach make a difference in the pool?

Research shows that decreases in swimming speed throughout a race are the result of decreases in the power-producing capacity of the swimmer (fatigue) and swim performance[8]. However, while this is an important area to consider when developing a swimming strength training programme, my experience working with elite swimmers indicates that there are two main areas that strength and conditioning coaches should focus on – starts and turns.

The training methodology here will not only improve your swimmers' explosive power so that they can get off the blocks at the start of the race and explode off the wall at every turn, it will also have a positive impact on power production during the actual stroke, as well as injury prevention and rehabilitation. Research carried out in the former Soviet bloc confirms that explosive strength is vital for the swimmers seeking a fast starting take-off, and strong push-offs with the legs on the turns[9].

## How do we improve strength and explosive power?

Almost all muscles are used in swimming, from the top of your head to the tip of your toes. This is exactly how you need to develop the strength and power required to get off the blocks and out of the turns as quickly as possible. Isolation exercises are a waste of time, because this is not how the body works. Box 1 provides just four exercises that all help develop explosive starts and turns.

You will note that all of these lifts are **bilateral**. I've assumed that you will have already developed appropriate levels of unilateral strength before embarking on these more advanced techniques. If you adopt the increasingly fashionable **track start** for getting off the block then you will want to include several unilateral versions of the lifts described in this section to increase the transfer of training effect.

## Olympic lifts

We can't talk about explosive power development for swimming without discussing Olympic lifts. A lot has been said about the efficacy of Olympic lifts (clean, jerk and snatch), and whether or not they have a role to play in the development of sport-specific power.

I like to use these lifts with swimmers, but they are advanced

## Box 1: Core lifts

**Squat (front or back)**

While there are many variations, the basic squat is the foundation for nearly every functional movement involved in developing the all-important 'triple extension' required for fast starts and quick turns. Not only do you get all of the benefits of the more traditional back squat but you also start to train the recovery phase of the power clean (another core lift for developing explosive power):

1. With the barbell resting in a squat rack, grasp the bar with an overhand grip and step under the bar, placing it on your collarbones and shoulders;
2. Maintain a full grip on the barbell – do not rest it on your fingertips;
3. Continue to perform the squat pattern as you would a normal back squat;
4. The position of the bar allows you to maintain a better back position, develops the recovery phase of the power clean and focuses development on the quadriceps.

**Deadlift**

Another great exercise for developing the strength needed to go from a 'dead' start, as well as being the start point for the key Olympic lifts such as the power clean. Deadlifts are a simple exercise really, made difficult by over-trying and over-thinking:

1. Stand before the weight in a solid, shoulder-width stance (may be up to six inches wider), shin to the bar;
2. Bend at the waist and knees equally, and at the same time;
3. Grasp the bar fully and securely in an over-grip or an alternate under/over grip about waist width (may be up to six inches wider for comfort);
4. Looking straight ahead, your spine in a powerful flat position (not stooped over or rounded), steadily pull the bar and stand up;
5. Keep the bar close to the body throughout the lift;
6. Pause for a second of contraction and slowly bend your knees and lower back as you return to the starting position.

**Jump squats**

The jump squat is a great exercise in its own right, but can also be used with a conventional squat as part of a squat 'complex' or 'superset' (*ie* perform a set of squats and then, with minimal rest, perform a set of jumps squats). Using complexes allows you to develop the strength qualities of the lower body using the squat and then exploit the explosive properties of the lower limb using the explosive squat. You can use bodyweight or external loads (barbell/dumbbells),

just make sure you don't compromise technique for load:
1. Stand with your feet shoulder-width apart;
2. Sit back into a squat;
3. Jump up so that both feet leave the ground;
4. Land with your knees bent to absorb the impact;
5. Pause, reset your body and repeat.

**Stiff-leg deadlift**
This is an advanced lift and requires great hip/hamstring flexibility and the ability to maintain normal spinal curvature. It's an excellent choice for developing the swimmer's **posterior chain**.
1. To perform the lift, deadlift the barbell from the floor;
2. After standing, slightly flex your knees, lock your spine, and slowly bend forward at your waist by flexing your hip as far as you can without losing your normal spinal curvature;
3. Once you have lowered the bar as far as you can, reverse the direction and raise the barbell by hip extension back to the start position.

lifts. If you are not confident in the coaching of these advanced lifts you will still be able to develop power using the four lifts outlined in box 1. Olympic lifts are important for developing triple extension but it is important to realise that they are not the be all and end all.

## Programming

Simply having a collection of exercises that you can use as a coach to develop your swimmers' strength and power is a bit like having a recipe and only knowing the ingredients. What you need to know is how to put it all together – how much of each ingredient should you use, in what order and for how long.

The key thing to remember when putting together a strength programme for a swimmer is that it is not your job as the strength and conditioning coach to overload the swimmer with even higher volumes of training. Your swimmers' strength programmes should focus on developing strength and explosive power, which means high-intensity and low-volume training. Box 2 shows how these exercises can be combined.

### Box 2: Programming principles

**Sets**

When developing strength and power, your swimmers should be working low reps, which means they will be able to use more sets. You should be looking at no more than 20 sets per training session, which limits swimmers to about seven exercises per training session (that's why you need to pick exercises that are whole body to give you maximum impact). Remember you are not 'isolating' muscles, so there should not be lots and lots of exercises in this type of programme.

**Reps**

Your swimmers will be working within the one to eight rep range. If they are developing 'absolute' strength they will work at the top end of the rep range (between five to eight reps). To improve their **relative strength**, they will need to be working at the bottom end of the rep range (between one to four reps). The total number of reps for a session will be between 12 and 100 reps.

**Recovery**

Strength and power development is intense. The very nature of this type of training requires greater recovery periods for the musculoskeletal and neural systems. Anything from two to five minutes' recovery between sets is acceptable.

## Training tempo

Most programmes I see begin and end with the three programming principles given in box 2. A lot of coaches neglect the importance of lifting tempo. For muscles to develop strength, they need to spend time under tension (TUT). Tempo is simply a method that good coaches use to adjust the duration of the rep (*ie* TUT).

It is typically written as a three digit formula: Eccentric: Isometric pause: Concentric. When it comes to strength development the TUT for a lift may look like 2 0 1 (three-second lift with a longer eccentric phase, no pause and a quick concentric phase. If performing an explosive movement you may simply use an 'X' to indicate that the exercise is performed as quickly as possible.

Is the use of tempo necessary? Some will argue that it over complicates the programme, but my argument is that at the very least it informs the coach and swimmer how you want the reps to be completed. There is a huge difference in training effect if you complete a squat with an X 0 1 tempo compared to a 3 2 3 tempo. The first will develop explosive strength; the second will develop control and stability.

## Putting it all together

Table 1 shows an example of a typical programme that I've used in the past when working with elite swimmers. The obvious thing to note is that there are no 'sport-specific' exercises in this programme (no metronomes, no breaststroke movements), but there are plenty of exercises that will have an enormous transfer of training effect over to the start and turns.

This programme was for an elite breaststroke specialist developing relative strength. As you can see the programme adheres to the principles discussed in the previous sections:

- Exercises – just six exercises used in this session. The exercises included Olympic lifts and their assistance exercises such as high pull, front squat and stiff-leg deadlift;
- Sets and reps – the inverse relationship between sets and reps is observed with no more than four sets of each exercise performed;
- The inverse relationship between number of sets and number of exercises is also observed with no more than 20 sets spread throughout the six exercises.

## Summary

This programme should only act as an example of how you put the 'ingredients' together. It was developed for a specific swimmer, but it's highly likely that this programme would have limitations if replicated in its entirety with all your swimmers.

However, as a coach you need to start thinking about how dry-land training can influence swim performance, decide on the exercises you are going to use to develop the appropriate strength and power qualities, before finally putting it all together using the training principles outlined in this article. Circuit-based training sessions still have a place in the overall swimming programme, but you should be thinking about incorporating some of the lifts outlined in this article into a specific strength and power training session.

**Practical implications**

- Simply simulating swimming movements in the gym is insufficient for building transferable power and strength - instead, more fundamental exercises should be used;
- Land training volumes should be kept minimal to avoid excessive fatigue and attention to training tempo is also important.

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# SWIM SMART, SWIM FAST

**At a glance**

- The basic fluid dynamics affecting swimming performance are outlined;
- New research on the relevance of drafting to swimming performance in triathlon is presented;
- The role of swimwear in reducing drag and enhancing performance is discussed and recommendations made.

**The science of swimming is extremely complicated, involving the interaction of propulsive forces from the swimmer's arms and legs and the drag caused by water. However, by applying new research courtesy of fluid dynamics and supercomputers, all triathletes and open water swimmers can swim faster. Joe Beer explains…**

Few sports are as precise as swimming. Cyclists can blame the wind, runners the terrain and team sports players the referee! Swimming, on the other hand, has exact distances and water is, well, constant. However, although 'pure' swimmers race in the pool and triathletes in open water (or OW as it's referred to), the advent of long-distance swimming entering the Olympics in Beijing and fast-moving swimsuit and wetsuit technology means that many 'constants' in the world of swimming aren't so constant after all.

The 'sports ground' for swimming ($H_2O$!) is often quoted as being 1000 times denser than air. Trying to move efficiently through this very dense medium is not nearly as easy as other sports that take place through air. For example, top cyclists hit over 60kmh in short events on the track or in an end-of-stage sprint. Elite runners average over 30kmh for a quarter mile and over 40kmh at the end of sprints. By contrast, even the world's best swimmers top just 8kmh (5mph) over the 100m sprint. Yet that is still superhuman. Most fitness swimmers would fail to approach even half that speed. All that splashing around by even the most enthusiastic fitness swimmer is soon put to shame by the 12 year old who glides through the water with ease. In short, swimming is about brain not brawn, and it's technique not triceps or trapezius size that matters.

To help ease the frustration that many people feel when trying to swim faster, this article looks at recent research papers and expert insight to glean some useful tips and tricks for swimming faster and more efficiently. In a sport where evolution of techniques, training knowledge and equipment are as meticulous as any other, there's much to learn.

## Drafting with a super computer

Computational fluid dynamics (CFD) emerged in the mid 1990s to investigate such areas as flight and propulsion in animals. These computers are loaded with page-long equations, performing millions of calculations per second to compute findings and produce models never before possible by pen and paper mathematicians. Experts keen on the science of swimming started using CFD to measure and understand better the flow around a swimmer's body. The result has been that it's increasingly possible to make models that can predict what is happening in the watery world that surrounds a swimmer.

A recent CFD paper presented by a group of seven experts from Portugal, although mind blowing in its mathematical methods, has produced conclusions that are both practical and written in plain English. Using complex equations, the group modelled the flow around two swimmers at varying distances from 50cm to 8m apart from one another. The flow speed was 1.6 to 2.0 metres per second, a rate that few but the fastest swimmers in water will ever approach, except maybe in a downhill water park ride!

The resulting pressure profiles of the two swimmers showed what you might expect, and maybe felt at times; that is, the lead swimmer has to work harder to deal with pressure caused by water resistance while the drafting swimmer has lower pressure to deal with[1]. However, the most interesting finding is that the drag increases on the trailing swimmer as they move from 50cm behind the lead swimmer to around 5 metres. Thereafter any further increases in distance between swimmers makes no difference as both now exhibit the same drag.

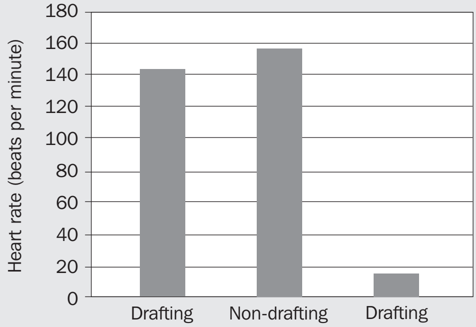
As slower speeds occur in competitive swimming where drafting is allowed (eg age group triathlon with swimming speeds generally less that 1.25m per second) it may be that the effective draft zone is somewhat smaller for mere mortals and thus swimmers must stay much closer than 3 metres to get a 'pull' from a leading swimmer. Anecdotal perceptions from swimmers used to group and open water drafting suggest that as you move to within 2 metres of the lead swimmer's toes, you start to feel a significant drop in drag. Data suggest getting as close as 50cm is best but up to 1.5m still results in a significant drafting effect (*ie* reduction in drag)[2].

The downside of this particular research was that the model used could only look at totally submerged bodies, which obviously is not a real-world scenario. It gives us some good clues, but the authors acknowledge *'In the future we aim to evaluate active drag while the swimmer is kicking'.* Other research data from the pool confirm the drafting effect. Swimmers who train in a pace line often choose to be closer than the required 5m that 'should' really be maintained between swimmers because they know it saves them energy. All except the lead swimmer can be on a much easier 'set' by close drafting.

If you draft, you go faster for the same effort or find it easier to hold a pace as your lactate (a blood marker of fatigue) levels are lower[3]. In some cases it has been shown that blood lactate levels can drop by 33% if the trailing swimmer drafts correctly[4]. This could result in a useful easing of mental effort or alternatively it saves some energy resources for a change of pace or higher speed effort later in the race (*see figure 1 on heart rates and drafting*).

Some of the most recent data presented on the concept of drafting from the Netherlands reports significant reductions in drag (and thus oxygen consumption) when drafting directly

**Figure 1: the effects of drafting on heart rate at 500m of 600m-time trail**




behind a lead swimmer[5]. Swim to the side of the lead swimmer and the benefits are smaller. Most interesting of these findings was that the front swimmer's kick can affect the benefit that drafting swimmers gain. It's likely that higher velocities in the turbulent 'kicked' water actually raise drag around the drafting athlete. Put another way, if you find yourself being drafted, upping your kicking effort can make it harder for those behind. Kicking can cause half of the drag reduction the drafter was getting to vanish!

And finally, for triathletes who swim then bike, some interesting data actually shows that by drafting in the swim, it's possible to improve subsequent cycling efficiency. Almost 5% more efficient cycling resulted when athletes drafted a lead swimmer compared to swimming alone[6]. Remember this well by reading it several times; water is very dense so let someone else push it aside for you! Of course in 'pure' swimming galas and meets with one swimmer per lane, deep pools and anti-wave ropes means physical drafting is not an option.

## Should you rock and roll?

One particular technique touted by some coaches as the key to improved propulsion is that of conscious additional rolling of the hips. This rolling of the hip region occurs to varying degrees

### Thoughts of a swimming coach

In theory, the trunk acts as a stable base on which to pull the swimmer forward whilst also stabilising the leg kick occurring behind. However, actually knowing what goes on when the front crawl swimmer is immersed in water is far from clear. These are the thoughts of leading UK swim coach Dan Bullock:

*"I have long felt that good rotation (but not excessive) and a mechanically sound leg kick will provide the stable base from which to make better use of your arm-pull. You may have read or been lectured on the importance of 'driving from the hip' while swimming front crawl, and how this generates more power through the stroke. I have always found this hard to implement.*

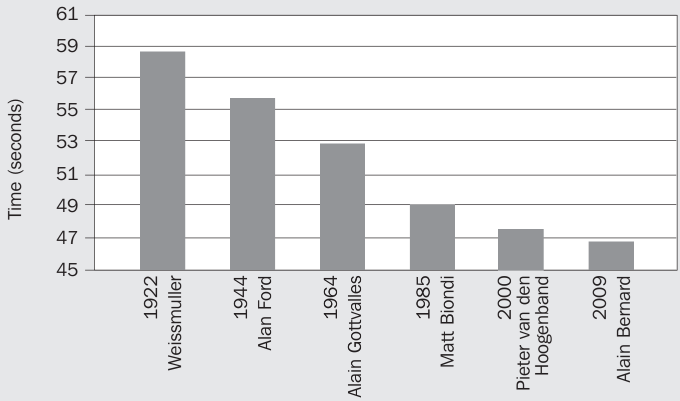
*After swimming recently while using a pull buoy, I could feel how my pull was weakened, which made it harder to set up my catch. In several sessions I oversee I have noticed that the stronger kickers are also the faster swimmers. Not conclusive by any means but something to think about for triathletes! If you are swimming around the 24min mark for 1500m and are looking for the breakthrough to 21mins then this is most likely where the breakthrough will come from since the arms are unlikely to get much stronger or longer!"*

dependent on what footage you see of which swimmer in a particular event. However, it has been suggested that voluntary and intentionally exerted body roll – for the purpose of generating additional propulsive forces – seems to run the risk of reducing the ability of the trunk to provide a stable anchor for propulsive movements in the upper and lower extremities[7].

It seems then that the 'lead with the hips' approach is incorrect for the swimming chain of events to proceed efficiently. There are even those who suggest everyone should exaggerate the roll as their primary focus. The problem with excessive roll is its effect on the time each stroke takes to complete and the likely increase in drag. Neither is a good idea if you want to be efficient, faster, or both. Hip roll is a consequence of good propulsion and not something that needs to be excessively forced to happen in order to try aid propulsion.

Swimming involves propulsive forces generated by the hand, forearm and upper arm pulling against the water, while the legs

**Figure 2: progression of men's 100m swimming world record**




provide additional lift and propulsion. You can get quite a lot of propulsion from the feet but using feet is energy intensive; pure swimmers can kick like a motorboat but the triathlon community must watch this lower body energy use as they still have a bike ride and run to complete!

## Suitable suits

The new generation of super tight, high-tech fabric swimsuits has caused a stir, with some saying that they give an unfair advantage. These range from full-length neck to ankle suits down to legs-only versions that look like a track sprinters' bare torso training kit, but what they have in common is that independent testing has shown they do improve performance by reducing drag on the swimmer.

In a recent study, researchers took 14 competitive swimmers and measured performance, stroke rate and distance per stroke in normal, first generation full-body and legs-only suits in a 25-metre pool[8]. In addition, a flume was used to measure drag. This is a moving water version of a wind tunnel, giving pinpoint accurate water speeds. In this particular study the swimmers were dragged with a rope hooked up to a load-measuring device without any arm or leg movement. This allowed drag from the suit to be isolated.

The suits tested were 'first generation' suits including the Speedo Fastskin, Arena Powerskin, Tyr Aquashift, ASCI and Nike Lift. These designs focus on reducing drag losses, and thus the buoyancy of the swimmers was not affected. This is significant because the very latest generation of suits, such as the arena X-Glide, are designed not only to reduce drag around the swimmer, but also to aid buoyancy. A quick glance at the tumbling swimming records over the past five years and the suits lining up on poolside suggests something is happening that is not just a coincidence. After all, world-class swimmers have always trained hard and peaked bang on time, to suggest otherwise is missing the point – these 'super-suits' are super fast!

In the study above, the six freestyle distances timed in the pool (25, 50, 100, 200, 400 and 800m) were 2 to 4% faster in a full-body suit, and around 2% faster in a legs-only suit[8]. Specific flume measurements suggest a 4-6% drop in drag is the main effect of these first-generation suits. For example, in the 100m, Pieter van den Hoogenband beat the legendary Alexander Popov's time of 48.21secs by three-quarters of a percent, in what we now call a first-generation fast suit. Moreover, in the last 18 months the 100m-world record has dropped more than it did in the 8 years from Matt Biondi's in the 1980s to Popov's in the 1990s. The 100m world record time has dropped by 6.8% over the last 80 years whereas the time taken to swim 100m has dropped 19% in the same period, 2.6% of that in the past decade (see figure 2)! Over the last 40 years, 100m running times have improved by 3% but swimming times by a massive 11%!

However, the swimsuit options open to elite swimmers will soon be restricted. On 1 January 2010, FINA is bringing in stringent rules likely to kill off many super-suits. However, in the sphere of triathlon, where innovation is applauded, the improvement of swim technologies looks to herald faster one-piece suits for the elites swimming in non-wetsuit races and also to wetsuits themselves, which are often seen as a buoyancy aid. Recent data using triathletes suggests that the wetsuits' ability to improve swimming is down to propulsion efficiency through a gain in buoyancy and to drag reduction across the body(9). The use of a good fitting wetsuit, smart drafting and reasonable open water sighting skills helps to produce a fast and efficient swim time.

## Summary

So there we have it. Drafting, a natural hip roll and a good swimsuit/wetsuit can all increase swim speed. More research is still needed into how to optimise all of these factors to aid swim speed and efficiency but whatever your aquatic goals, a little knowledge goes a long way to helping smooth your path through *aqua communis*!

### Practical implications

- Efficiency is central to swimming – measure how well you move through water by counting your strokes per length over a continuous swim (eg 400m);
- Swim golf – combine the time to swim 100m with your total stroke count to get your 100m-swim golf number. For example, 1:35 (95 sec) and 84 strokes give a total of 179. Better speed for fewer strokes shows an improved efficiency;
- Speed suits make a difference. Triathletes who swim pool triathlons or 'no-wetsuit races' should find a fast pool suit and an open water go-fast suit;
- Hairy triathletes or master swimmers unable to bring themselves to trim chest, leg and back hair should look to use a high neck suit that goes to thigh level. Less drag means more speed;
- In open water swims or triathlons, or pool triathlons with several swimmers per lane, be sure to draft if you can. Even a brief time close to a faster swimmer can bring relief with no loss of speed. Learn to look for a feeling of bubbles just ahead of you.

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# Does it matter to triathletes and open water swimmers?

**At a glance**

- The physics of body density, drag and swimming performance is outlined;
- Recent research on the optimum body composition in swimmers is presented;
- The issue of body image and composition in younger swimmers is discussed and recommendations made.

**Just as in other sports, body composition can play an important role in swimming performance. But what does the latest research say about optimum body composition for swimmers and how best to achieve it? Andrew Hamilton investigates**

In most sports, achieving optimum body composition is relatively simple and governed by two simple rules. Firstly, lower levels of body fat equate to less 'dead weight' and improved performance; secondly, providing the dietary fundamentals are correct, training for that sport will help to bring about optimum body composition. For swimmers, however, things aren't quite so straightforward.

On land, superfluous body fat acts as a 'dead weight' that blunts acceleration and makes work against gravity (which takes place in any sport that involves running or moving around on foot) more energy demanding for the muscles having to do the work. Since all the propulsive force required to overcome gravity and inertia comes from muscular contraction, having a high power-to-weight ratio (*ie* plenty of lean muscle tissue and a minimum of body fat) makes moving around on land much easier!

In the water, however, things aren't so simple and that's because unlike most other body tissues, body fat is less dense than water (*see table 1*). In simple terms, a given volume of fatty tissue weighs less than the same volume of lean muscle tissue, because fat is inherently less dense than water, and lean muscle tissue contains much more water than fatty tissue.

| **Tissue type** | **Density (kg/m3)** |
|---|---|
| Blood | 1,060 |
| Bone | 1,810 |
| Bone marrow | 1,810 |
| Cartilage | 1,100 |
| Eye | 1,170 |
| Fat | 920 |
| Lens | 1,100 |
| Muscle | 1,040 |
| Nerve tissue | 1,040 |
| Optical nerve | 1,040 |
| Skin | 1,010 |
| (Water ) | (1,000) |

**Table 1: Relative densities of different body tissue***

*Over 1,000kg/m3 is more dense than water, under 1,000kg/m3 is less dense than water

Marc André Golombeck, 1999

Applying Archimedes' principle of displacement, a body of lower density than water immersed in water is buoyant (*ie* will rise to the surface), whereas bodies of higher densities than water will sink. It follows therefore that the more body fat a swimmer carries, the more buoyant he or she will be in the water.

Given that swimmers need to stay horizontally aligned on the water's surface for maximum speed through the water, and that they expend energy in doing so, it seems intuitive that, unlike land-based athletes, higher levels of body fat could be advantageous for them.

There's also another reason why higher buoyancy has been regarded as a plus for swimmers; any body moving through water creates 'drag', which acts to slow that body down. For any given body weight, the higher the percentage of body fat, the more buoyant the swimmer will be. This in turns means that less of the body will be under the waterline, which will in turn mean less drag to overcome – *ie* more of the propulsive force can be turned into forward motion. This explains why in days gone by, many swimming coaches considered higher levels of body fat as an asset in their swimmers.

## Hydrodynamics and form drag

Like many things in life, however, it's not that simple. While extra buoyancy in the water confers real advantages, piling on pounds of fat can result in slower movement through the water, and that's down to something called 'form drag'.

As anyone who's ever watched a wildlife programme on seals will testify, the transformation of the seal from a fat, lumbering and awkward looking creature on land to the epitome of beauty and grace in the water is amazing to witness. But while seals carry typically about 30-50% body fat(1), it's distributed evenly around the body and in a manner that doesn't impede its extremely efficient hydrodynamics.

However, when humans carry extra body fat, it's carried unevenly. As a swimmer fattens up in the abdomen, thigh, and buttock areas, movement through the water produces swirling eddy currents around these protruding areas and can slow swimming velocity appreciably – this is form drag, which works against the buoyancy gains.

In the natural world, fast-swimming fish and mammals such as sharks and dolphins all have exceptionally low form drag. A marlin can weigh nearly a tonne yet clock up underwater speeds approaching 50mph! This is largely due to its exceptionally low form drag that results from its almost 'Concorde' shaped frontal profile, combined with powerful musculature. It also explains why boats have slim, smooth hulls with tapered ends rather than hulls that are brick-shaped or with protrusions sticking out.

Form drag is also increased by poor alignment when moving through the water. For example, if your legs begin to drop or your head rises in relation to your trunk, this presents an additional frontal area, which increases form drag (*see figure 1*). There's also 'skin drag', which is a frictional drag caused by turbulence as water moves over the skin's surface. However, for the purposes of this discussion, we'll restrict ourselves to considering only those aspects of swimming performance directly related to body composition.

Increasing body fat in swimmers increases buoyancy (aiding performance) but also increases form drag (a hindrance). The obvious question, therefore, is which exerts a more powerful effect as body fat levels rise? To answer this, scientists at the University of Miami artificially increased body fat levels by 2% or more in a group of 10 male and female swimmers who had been swimming competitively for at least three years(2).

This was achieved by fitting latex pads under a spandex triathlon suit in the same areas where swimmers might be expected to gain body fat – *ie* the abdominal, hip, thigh, chest, back, and buttock areas. Microscopic balloons were also added to the latex so that the pads had the same density as actual body fat. Male swimmers attached a total of 3.3lbs of artificial fat, while females donned an extra 4lbs. Before and after the 'artificial fat gain', each athlete swam 50yd freestyle at maximum effort in a counterbalanced design, swimming twice under each condition (to ensure any differences were due solely to 'fat' changes and not fatigue).

While the artificial fat improved buoyancy, it also slowed the swimmers down considerably, increasing the 50yd time by about 0.8secs or about 0.2secs per additional pound of fat added. In other words, the detrimental effects of increased form drag greatly outweighed any benefits of increased buoyancy.

Does this mean that lower body fat is always beneficial to a swimmer? Not necessarily. As the authors of the above study cautioned, their subjects were chosen to have 25% or less body fat for females and 15% or less for males. However, these are not particularly lean values for athletes; it could be that their buoyancy may have been adequate already with little to gain by adding more. The same might not be true for very lean swimmers, where very low body fat in the lower body can make it harder for them to keep their legs horizontal in order to maintain a streamlined position. Where this is the case, extra buoyancy may help aid a streamlined position, resulting in a net drop in overall drag.

Gender may also be important in this respect. All other things being equal, women tend to carry more body fat than men, and thus will tend to be more buoyant in the water. Moreover, female fat tends to be disproportionately distributed in the lower half of the body, giving a bit more lift to the legs, which in turn reduces form drag.

But while a very lean male swimmer may gain a net advantage by increasing his body fat somewhat, this certainly doesn't provide a licence to pack on the pounds. That's because males tend to put on excess body fat in the abdominal region; an expanding waistline shifts their buoyancy forward, which in turn tends to make the legs sink, increasing form drag.

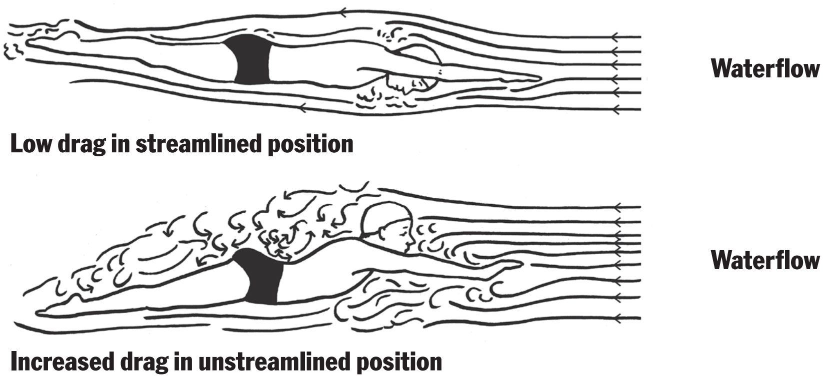
This is easily demonstrated by the fact that most men can swim faster with a float between their legs than without it whereas most women experience little or no improvement when swimming using a leg flotation device.

## Optimum body composition

All of this begs the question of what the optimum body composition for efficient swimming is. That's a tricky one to answer, as it can depend on so many other factors such as body distribution, body shape and the nature of the swimming event.

Emeritus Professor David Costill, a highly respected exercise physiologist and masters swimmer, has suggested that in masters swimming at least, optimum body fat levels range from 10% to 20% for men and from 15% to 25% for women[3].

**Figure 1: Form drag and alignment in the water**




More recently, however, US researchers at the highly regarded Councilman Research Lab at Indiana University have claimed that body composition may not be particularly relevant in sprint performance and that (in men especially), muscular power is what really counts(4).

By contrast, a study on male water polo swimmers suggests just the opposite(5). In the study, Greek researchers took anthropological and physiological measurements from 19 professional water polo players. These included body composition (using a highly accurate X-ray based technique known as DXA), **lactate threshold**, the energy cost of swimming, peak oxygen consumption, **anaerobic capacity** and shoulder strength.

The researchers first set out to determine the polo players' average lactate threshold and found that it occurred at a swimming velocity of about 1.33m per second and at a heart rate of 154bpm. They then measured the average energy cost for swimming at this 'lactate threshold velocity' and discovered that it was in the region of just over 1kJ per metre. When they then looked at how this was affected by body composition, they discovered that the higher body mass indexes (BMI – weight in kilos divided by height in metres squared) of the players were correlated with higher energy costs – *ie* the higher the players'

BMIs, the more inefficient they were at moving through the water at lactate threshold pace.

However, a word of caution; higher BMI and percentage of body fat are not the same thing. Although high BMIs are often associated with high levels of body fat, this is not always the case – for example in athletes who are very lean but have large bone structure and who carry large amounts of lean muscle. That said, lower BMIs tend to point toward slimmer, leaner

### Optimum body composition for cold water swimmers

A Formula 1 racecar might be the quickest thing on 4 wheels round a track, but stick it on a bumpy and potholed back road and it would easily be outrun by a basic rally car with less than a third of the power. Likewise, the optimum body composition needed for outright swimming speed is not necessarily the same as that needed for open water swimming, especially where the use of wetsuits is banned or restricted.

As well as providing a rich energy source, stored body fat is an excellent insulator against heat loss, which explains why cold water mammals such as seals store around 3 times as much body fat as we do. It's not surprising therefore that most accomplished long distance swimmers are not built like beanpoles!

As explained by Greg Whyte elsewhere in this report, muscle power output drops by 3% for every 1 degree C drop in muscle temperature; if your event involves swimming long distances in cold water without full wetsuit protection (ie where maintaining core temperature is a problem), trying to drop a few % body fat to achieve a lower coefficient of drag could well be counterproductive as the performance drop produced by the extra heat loss could well exceed any potential performance gains."

physiques and in this study at least, more efficient movement through the water at higher velocities.

## Body composition pressures

Competitive swimmers are often young and therefore impressionable. This makes them vulnerable to pressures to conform to the 'ideal' notion of body composition. These pressures can come not only from their coaches who may have pre-determined (and often unscientific) ideas about what weight/body composition their swimmers should be, but also from the fact that competing in swimsuits in the public arena can add further pressure.

Studies in the 90s reported that swimmers often feel pressure to drop weight[6] and that many coaches of female Olympic swimmers encouraged their swimmers to lose body fat in order to cut times[7]. More generally many swimming coaches routinely advocate about 15% body fat as an upper-end cut-off for elite female swimmers.

However, when double Olympic gold medallist Tiffany Cohen won her 400m and 800m golds at the 1984 Los Angeles Olympics, her body fat was reported at 22%. This is not to say, of course, that 22% is the ideal level of body fat for females swimmers. It merely illustrates that there are no hard and fast rules about what constitutes the optimum percentage of body fat for a particular swimmer because every individual possesses a unique blend of physiological and anthropological characteristics.

In a study of 62 female swimmers from seven US college swim teams, researchers set out to assess the pressures to conform to weight 'norms' experienced by the swimmers[8]. Over half (51.6%) of swimmers agreed with the statement, 'There are weight pressures in swimming.' The most commonly cited pressures were as follows:

- Wearing a revealing swimsuit (45.2%);
- A perception that lower weight helps swim performance (42%);
- Team-mates noticing my weight (16.1%);
- The crowd scrutinising my body (12.9%);
- The belief that the lightest swimmers have a performance advantage (9.7%).

The focus on achieving a headline body composition figure rather than achieving improved swimming performance is not only unhealthy and unproductive, it can signal the start of more serious problems of self-perception, and may result in eating disorders.

Interestingly, although competitive suits are typically one-piece styles, many participants reported that they wore swimsuits two or more sizes smaller than their typical size and some even wore youth sizes in order to prevent drag. This is consistent with the belief that decreased weight and body fat are associated with increased performance. Unfortunately young swimmers then preach the same beliefs when they become coaches themselves. Coaches should therefore approach this issue with caution, and recommendations are given in box 1 below:

**Box 1: Recommended coaching strategies to minimise 'weight pressures' in swimmers**

**Reel and Gill, 2001**[8]

- Eliminate weight requirements and weight-related goal setting.
- Avoid group weigh-ins.
- Allow team members to choose team suit whenever possible.
- Educate swimmers about muscle weighing more than fat.
- Encourage swimmers to meet caloric intake needs.
- Discourage team members from making weight-related comments to other swimmers.
- Evaluate your beliefs about weight-performance relationship.
- Monitor swimmers' eating behaviour/body concerns and look for 'at-risk' swimmers.
- Listen to swimmers' concerns about weight and body.
- Encourage 'at-risk' swimmers to keep a food log to ensure adequate caloric intake.
- Be prepared to refer an athlete as needed.
- Watch comments that suggest swimmers should drop weight to cut times.

## Swimming, weight loss and appetite

At this point, you may be wondering what the big deal is? Surely, performing adequate volumes of swimming training will automatically bring about optimum body composition, and produce a fat/weight loss effect if needed? Although this seems intuitively correct (after all, it happens in other sports such as running and cycling), the research in this area suggests otherwise.

One reason is that during swimming, the body's weight is supported by the water. In contrast with running, for example, where each stride involves work against gravity, weight gain in a swimmer does not incur an energy expenditure penalty. If you weigh 70kg and run 10 miles a day, you'll burn up about 1,000kcals per day during training. Gain 7 kilos of body fat and your energy expenditure increases by about 10% – *ie*, you'll burn about 1,100kcals per run. Put simply, the more weight you carry, the higher the calorie burn and therefore the greater the weight-reducing effect. However, a swimmer who gains a similar amount of body fat will incur virtually no extra energy costs and therefore weight-reducing effect during training.

In a fascinating study, scientists looked at the weight loss/gain effects of walking, cycling and swimming programmes conducted over a three-month period[9]. Each programme began with up to 10 minutes of daily exercise and the length of each workout was increased by five minutes every week, so that participants were averaging 70 minutes day at the end of the programme. The results showed that while the walkers and cyclists lost 17 and 19lbs of weight respectively, those performing the swimming programme actually gained 5lbs despite burning a similar amount of calories!

The researchers surmised that (in addition to the issue of supported body weight) swimming in cold water stimulated the appetites of the swimmers to increase caloric consumption. Further evidence of these two effects can be seen in comparisons of competitive swimmers with runners or cyclists who expend a similar amount of energy when they train; swimmers typically have body fat levels that are significantly higher then runners or cyclists. For example, comparative studies on male athletes competing in the 1964 Tokyo and 1968 Mexico City Olympics showed that the body fat percentage levels of long distance runners and marathoners ranged from 1.4-2.7%, while those for swimmers ranged from 9.0-12.4%[10].

However, a Lithuanian study suggests that a structured swimming programme does help reduce body fat[11]. This study actually set out to observe the health effects of a 14-week swimming programme in diabetic and healthy female girls aged 14-19. One of the main findings was that in both groups of subjects, swimming produced significant fat loss of about 2% of body mass compared to the inactive controls.

The cool water environment in which swimmers train appears to play a significant role in explaining why they may struggle to reach optimum levels of body fat. A 2005 study examined the effects of exercising for 45 minutes in neutral (*ie* around ambient body temperature – 37°C) and cold (20°C) water temperatures[12]. After the workout, they were allowed to eat as much food as they wanted.

The researchers discovered that although the men burned a similar number of calories in the cold and neutral water conditions (505 and 517kcals respectively), the calorie intake after exercise in the cold water averaged 877 calories – 44% more than in the neutral temperature water! Although 20°C is colder than most training pool temperatures (27-28°C), the latter water temperature is still cool enough to promote efficient heat loss during swim training and this will help to ameliorate the magnitude of the rise in core temperature that occurs during most exercise modes. This is significant because an exercise-induced rise in core temperature is known to result in appetite suppression both during and immediately after training. You've probably experienced this when starting a training session feeling peckish, only to find that 10-15 minutes into your workout, your appetite has vanished and doesn't return for a while even after training. This effect, however, appears to affect swimmers less.

## Conclusions

Unlike most other weight-bearing sports, there's no simple answer as to what constitutes an 'optimum body composition' for swimmers. Both excessively high and low levels of body fat appear to be detrimental to performance, yet striving for the 'perfect' level may not only fail to produce performance gains, but can also lead to unhealthy body image problems and even eating disorders.

Aiming for a 'perfect' body composition measurement is probably unproductive; a far better solution is to monitor body composition data (*eg* using skinfold measurements) in a training diary alongside your performance times. There's a high likelihood that your optimum body composition will be the composition that accompanies your best performance times!

## Practical implications

- Although more body fat increase buoyancy, excessive fat can increase drag and should be discouraged. Cold water swimmers however may benefit from higher levels of body fat than warm water swimmers;
- Coaches should monitor body fat levels in swimmers; however, they should be aware of creating unecessary anxiety about body composition, especially in younger female swimmers.

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# Surviving the hazards of open water swimming!

**At a glance**

- Learn which marine creatures are a threat and the signs, symptoms, and field management of a close encounter;
- Recognise the importance of maintaining core body temperature control in both hot and cold open-water conditions;
- Improve performance with tips on shoulder health, energy needs, and pacing.

**Open-water distance swimming is an ultra endurance event that challenges the most seasoned athlete. Alicia Filley explains the obstacles you must overcome to claim the glory at the finish…**

Whether you swim in a lake, river, or ocean, once you enter the water, you are not alone! Animals that pose a danger to humans include the blue-ringed octopus, various types of jellyfish, spiny fish, certain corals, sea snakes, and sharks (see table 1). Should you experience a sting, barb, or bite, try to determine which species is responsible. If it is during an event, you may decide to continue competing; however, communicate with your coach or guide so that you can be monitored. An alteration in stroke rhythm or failure to follow guide instructions may signal impending distress. If a wound is significant, treat locally by rinsing with fresh water; stop any bleeding; and seek medical attention.

Of the biting marine animals, the most feared is the shark. Data shows that there are on average about 50 shark attacks each year, with less than 10 of them fatal[1]. While your risk of

**Table 1. Common tropical marine animals, their mode of attack and clinical sequelae**

| Common marine animals | Means of attack (defense) | Signs & symptoms of Envenomation |
|---|---|---|
| **Jellyfish**<br>Box jellyfish (sea wasp)<br>Portuguese man-o-war<br>Pacific bluebottle | Sting by nematocysts | Localized pain and inflammation. Brief symptoms in mild cases. Severe cases: Nausea and vomiting; Altered state of consciousness respiratory/ cardiac arrest |
| **Spiny fish**<br>Stingray Stonefish | Sting by spines on body or tail | Acute local pain and swelling. Intensified pain at puncture site. Risk of secondary infection if untreated. |
| **Sea snakes & octopuses**<br>Beaked sea snake<br>Blue-ringed octopus | Bite from sharp beak or mouth | Painless bite. Myotoxicity – myalgia. Myoglobinuria Neurotoxicity – paralysis |
| **Corals** | Cuts, abrasions, lacerations | Acute stinging pain. Local inflammation. Pruritis. Secondary infection. Lymphadenopathy |

Data from Williamson JA: marine envenomation. In Fields KB, (eds): Medical problems in Athletes, malden, Massachusetts, Blackwell Science, 1997 p305.

injury is greater on the drive to the beach, shark attacks do occur. Most of them are 'hit and run'. Sharks take one bite either for practice or to explore something novel in their surroundings, much the same way babies put things in their mouths. The majority of fatal attacks are intentional feedings by the shark. These tend to be bigger sharks and happen in deeper waters(2).

Treatment for a bite wound varies with the severity and location of the wound. If bitten, leave the water immediately, attempt to stop the bleeding, and seek medical attention. Sharks typically feed in the evening hours in shallow waters within 100 feet of shore. Avoiding areas where sharks are known to feed is the best way to prevent attacks. A good rule for avoiding any sea creature is 'if in doubt, get out'!

## Tiny creatures, big problems

Some organisms that exist in open water are too small to see. Yet, you will know in short order if you've encountered one. It's an unfortunate fact that wastewater is frequently discharged near recreational sites and swimmers risk encountering all kinds of viral pathogens. For example, in 1999, the Swim around Key West race was held in Florida, despite the known water pollution present. Of the 160 swimmers who participated in the 12-mile race, 31% had at least one symptom of disease after the race(3). Most of the illnesses were gastrointestinal. The best way to prevent contamination is to avoid swallowing sea or lake water and to take a freshwater shower after swimming.

Other tiny organisms cause various types of skin problems in swimmers. A common one, called seabather's eruption, can occur in saltwater swimmers. The raised rash, usually in areas covered by the bathing suit, is a result of stings by very small thimble jellyfish, or the larvae of sea anemone. Treatment consists of careful removal of the bathing suit. Any nematocysts still present will sting again if disturbed. A freshwater shower with soap and water, hydrocortisone cream to the area, and over-the-counter systemic anti-histamines should relieve the symptoms. If the rash worsens or other symptoms occur, such as nausea, vomiting, or respiratory distress, seek medical attention.

Of course, protection from the sun is paramount when spending time in the open water. Sunburned skin affects your comfort level, your body's ability to regulate your temperature, and your hydration. Sunburn leaves skin more permeable to organisms present in the water and increases your risk of skin cancer. Proper and frequent application of sunscreen with an SPF of 40 or greater is recommended during all outdoor swimming.

## Temperature regulation

The biggest challenge of open water swimming is keeping the core body temperature near normal. Athletes are usually accustomed to their swimming environment and able to maintain core body temperature during training. However, changes in location for competitions may require prior acclimatisation.

Hyperthermia can be a problem for those used to swimming in hot climates. Competition in the heat may cause swelling of the hands and feet and increases the risk of dehydration. Dizziness upon standing, painful muscle spasms and cramping are all associated with dehydration and electrolyte imbalance. Re-hydrate with cool, electrolyte replacement liquids and retreat from the heat until your body cools down.

However, staying warm in cooler waters is the bigger challenge for most swimmers (see table 2). Hypothermia is defined as a core body temperature (CBT) below 35°C[4]. In it's mild form, hypothermia results in excessive shaking and shivering, impaired coordination, slowed speech and difficulty thinking

**Table 2: Stages of hypothermia**

| |
|---|
| ***Mild hypothermia – CBT 32-35°C**<br>Shivering will be evident. Swimmer should be advised to leave the water. Hypothermia may begin to impair judgement. |
| ***Moderate hypothermia – CBT 28-32°C**<br>Stroke rhythm and direction will be erratic. Swimmer may not respond to guide craft. Mental function impaired and loss of consciousness is pending. Swimmer should be removed from the water. Transition to severe hypothermia happens quickly. |
| ***Severe hypothermia – CBT < 28°C**<br>Swimmer will likely lose consciousness. Immediate rescue and emergent medical care is required. |

A swimmer may not recognise the signs of hypothermia. Interruption of the stroke rhythm or course progression may be the first signs of hypothermia observed by coaches. Swimmers should be advised to leave the water and re-warm by wrapping in blankets or taking a warm shower. Observe swimmers until symptoms resolve and temperature is normal.

Moderate hypothermia results when the core temperature drops to below 32°C. At this stage, shivering slows or stops, confusion is apparent, abnormal breathing and heart rate may be present, speech is slurred, and movements are jerky and rigid. Swimmers must evacuate the water immediately. Conservative re-warming by wrapping in blankets and drinking warm liquids can be conducted at the scene while immediate medical attention is sought.

A CBT below 32°C indicates severe hypothermia and constitutes a medical emergency. At this temperature, the athlete becomes unconscious and is at risk for drowning if still in the water. Heart rates drop and arrhythmias can result in cardiac arrest. Remove the swimmer from the water and seek emergent care.

Hypothermia is possible even when swimming in relatively warm waters. The International Swimming Federation (FINA), states that the water temperature for official competitions should be 16°C or higher. Investigators in Brazil studied the effects of open-water swimming on 12 competitors (seven men and five women) in the 2006 Brazilian Grand Prix 10K race, where the water temperature was 21°C on race day(5).

The CBT of these elite swimmers was measured before warm-up and within one minute of completing the race, using a tympanic membrane thermometer. This thermometer measures the temperature inside the ear and has shown good correlation to core temperatures. Three athletes finished the race with mild hypothermia and seven athletes exhibited moderate hypothermia. The difference in pre and post race temperature was greatest among the females.

The investigators do not reveal if the athletes demonstrated clinical signs of hypothermia or if treatment was given. They merely conclude that even while swimming in relatively warm water temperatures, you are still at risk for hypothermia. Tolerance to temperatures differs among athletes, therefore swimmers and coaches should be aware of the possibility of hypothermia under all conditions.

Also it's important to realise that the concern for hypothermia doesn't end when you leave the water. Researchers in San Francisco, California, studied the phenomenon of afterdrop during the 1998 New Year's Day 3km Alcatraz Swim[6]. The water temperature on race day was 11.7°C. Six male and five female subjects were dried, changed into hospital gowns, covered with blankets, and monitored immediately post race via rectal thermometers. Temperature and heart rate were monitored every three minutes for 45 minutes.

Afterdrop was evident in 10 of the 11 subjects. Noting the incidence of afterdrop, the authors conclude that accidental hypothermia is a very real risk with open water swimming. They recommend that participants be monitored at the completion of events until signs of hypothermia are gone.

## Man versus man

You may assume that open-water swimming is an experience in communing with nature. Sadly, your fellow man frequently leaves his footprint in your playground. Swimmers must be aware of submerged objects in the surf. Old pilings, piers and jetties pose a real danger to swimmers. Consult with local fisherman and lifeguards about possible submerged objects and be wary of currents that push you toward them.

Boat traffic is another man-made danger in the open water. A swimmer is difficult to see from a fast moving boat. And to be honest, most recreational boaters aren't even looking! To minimise your risk, swim at times when the water is less busy, such as the early morning. Wear a brightly coloured cap and goggles; place reflective tape on the back of your cap or wet suit; and whenever possible, swim with a guide boat or group.

## Man versus himself

Humans were not built to use swimming as a primary means of locomotion. Most overuse injuries result from doing too much too fast, or doing it incorrectly. In swimming, the shoulder joint and muscles are heavily involved in producing most of the forward momentum and this region therefore is the most prone to injury.

Swimmer's shoulder syndrome is an overuse injury caused by instability within the shoulder joint. This instability is a result of excessive shoulder range of motion, the imbalance of muscle strength around the joint, or fatigue of scapular (shoulder blade) stabilising muscles[7]. At the first sign of shoulder pain, swimmers should seek medical evaluation; the 'no pain, no gain' credo does not apply to the shoulder!

Treatment includes rest from painful activities; over-the-counter, anti-inflammatory medication for two weeks; increased stretching of the back of the shoulder; and shoulder girdle strengthening exercises. The best prevention strategies are attention to stretching the back of the shoulder equally or more than the front, and integrating a rotator cuff strengthening program into your training routine.

Having enough energy to power those shoulders is a challenge to endurance swimmers. While a marathon runner uses about 3,000kcal in 2.5 hours of running, a marathon swimmer needs 12,000-15,000kcal in a 14-20 hour race[8]! Like other endurance athletes, marathon swimmers are at risk for dehydration, electrolyte imbalance and carbohydrate depletion. However, if a swimmer stops to feed, they have lost the race.

Because feeding is so important in this type of event, technique must be practiced. Swimmers should be well hydrated before swimming, stash food-gel packets in their suits and coordinate nourishment along the way. Carbohydrate replacement needs can be calculated from oxygen consumption studies in the pool. Trainers and exercise physiologists can assist you with calculating these needs if you are 'hitting the wall' during training.

These same specialists can assess your fitness by correlating heart rate with lactate production. By determining what heart rate allows you to swim at just below your lactate threshold, you can calculate what pace will give you the greatest endurance capabilities. Performing at your ideal stroke rate also allows you to work at the highest intensity possible for the longest time.

When eight elite open-water swimmers were evaluated during a one-week training camp, researchers in Connecticut found the lactate threshold of the males to be at 88.75% of their peak velocity(9). The females' lactate threshold was at 93.75% of their peak velocity. Operating this close to the anaerobic threshold during a competition leaves little room for increased performance such as for tactical sprints. Training, therefore, should enhance peak velocity, while maximising the power output at which lactic threshold is reached.

As you embark on your personal odyssey in the open water, keep in mind the obstacles that lie before you. Peril is present below you in the murky water, around you as your fellow man stakes his claim on the lakes and seas, and within yourself as you push your body to its limit. What awaits you at the finish, however, is the pride in an accomplishment few others ever achieve. Stay the course!

## Jargon Busters

- **Nematocysts –** The stinging cells present in jellyfish tentacles that continue to function, even when separated from the jellyfish or if the jellyfish is dead. Care must be taken on their removal since they are still active
- **SPF –** Sun protection factor designates the degree to which a sunscreen lotion offers protection from the sun's ultraviolet rays. The higher the number, the greater the protection
- **Acclimatisation –** Getting your body used to a new climate and water temperature so that core body temperature remains nearer normal when exposed to that climate
- **Afterdrop –** Continued cooling of the core body temperature after removal from the cold

## Advice from an expert

No one knows how to survive and win in the open water better than John Kenny. A former collegiate swimmer, John's ten-year career with the Atlantic City Beach Patrol brings a unique awareness of water safety to the sport of marathon swimming. John is a five-time US national champion in open-water and currently competes at the international level, most recently representing the United States in the 25K at the 2008 World Championships.

Although recently stung by a Portuguese man-of-war jellyfish, John worries least about marine life. He advises swimmers to "do your homework" and be aware of the species in your waters. For those less 'at home' in the water, he cautions to be aware of rip currents, waves, and 'hidden' moving water. Lifeguards and locals are the best resource for information about these.

John's finds the greatest threats to his safety to be man made. Recreational boat traffic is his number-one concern. This gives rise to his number-one rule: never swim alone! When swimming in open water, buddies are good, groups are better, and escort crafts are best. He cautions, "Try to avoid any objects you can see, and do your best to research if there are any hidden dangers in the area."

Whether you are trying to stay cool in warm water, or warm in cold water, John offers this important advice, "Be aware of your core temperature and have a plan for getting out of the water if it goes too far one way or the other." Despite his prolonged career swimming extreme distances, he boasts healthy shoulders due to cross training. He targets smaller muscle groups, which tend to be the 'weak links' in the shoulder, for strengthening. John stresses proper form as a key to staying healthy. "If your technique breaks down, you will encounter extra stress than can eventually lead to injuries."

John emphasises that open-water swimming is as much a mental as a physical sport. "Increased fatigue and decreased focus will make a swimmer more likely to deviate from their course," he says. When panic sets in, he recommends visualisation and positive thoughts. Imagine you are in your training pool and try to relax. The best way to prevent panic is to practice out in the open water under different conditions: wind, wave, calm, heat, and cold. Be prepared for anything Mother Nature may dish out!

**Practical implications**

- The biggest hazard facing open water swimmers is temperature regulation. Swimmers should therefore follow the recommendations on safety made here, train in the conditions they expect to encounter during an event, and equip themselves accordingly with appropriate swimming wear;
- Marine creatures and manmade hazards are also a problem – open water swimmers should take sensible precautions wherever possible.

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# The inspiration that is Julie Bradshaw

**When it comes to open water distance swimming exploits, there's one name that trips off the tongue among aficionados. Julie Bradshaw MBE has already swum more open water miles than most of us will ever run or cycle in a lifetime and earned herself a list of world record titles in the process. Andrew Hamilton looks at her inspiring career…**

Even as a kid, Julie loved swimming and it wasn't long before she started training with a club. But by the tender age of 11, she realised that she was a bit different from most other kids. You see, she loved cold water and recalls one occasion where the heating system at her local pool broke down. "We started a pool session in really cold water. Bit by bit, all the others got out unable to continue and I ended up in there on my own – I loved it!"

Two years later in 1977, Julie was on a caravanning holiday with her parents in the Lake District area of Northern England. During a visit to Troutbeck Bridge, she noticed a sign up about the annual Lake Windermere swim. On the spur of the moment, Julie entered here first ever open water swimming race, which even now she holds dear to her heart. "I remember it so well. Funnily enough I swam it breaststroke, which was just about my worst stroke, but that allowed me to keep my head above the water. I completed the course and although I didn't win anything, I got a good buzz out of it."

Enthused by whole open water experience, Julie returned to her home town of Blackpool and began open water training in earnest. By coincidence, she also had a friend who was preparing for a cross-Channel swim and they trained together in the sea, up and down the shoreline as well as in the Blackpool Open Air Pool.

It didn't take Julie long to discover that she had bags of natural ability. "I ended up out swimming and out pacing my training partner!" exclaimed Julie. "So I decided to enter the following year's Windermere race, but this time with a view to racing rather than just completing the event." One year later, at the age of 14, Julie returned to Lake Windermere still as a junior and swam the 10.5 miles freestyle from end to end in just 4hours and 38 minutes, setting a British Junior record. Later that year, she set another British junior record by swimming across Morecambe Bay in 2 hours 48 minutes. By the time autumn had closed in, Julie was well and truly bitten with the bug and thought "If I can perform this well after just one year's training, maybe I should set my sights on the big one – the English Channel.

## Toughest test

With her school exams out of the way, 1979 saw Julie preparing for her cross-Channel attempt. While some open water swimmers scoffed at the notion of preparing for a Channel swim with just two years' open water swimming background and only one year's specific preparation, Julie had other ideas. "I was lucky in that I had plenty of backing from my parents, although they were never pushy," she added. "I trained all winter with my swimming club in the pool, then come the spring, I started training outdoors doing longer and longer swims to build up my endurance."

By August of that year, Julie was ready for her toughest test yet. She took up the story; "My family used to laugh about my swimming exploits and the weather. Everywhere I went, it seemed as though the bad weather followed me. It was the same for my cross Channel attempt. You don't just turn up and swim – everything has to be registered and set up in advanced with the Cross Channel Swimming Association, you need to have a qualified pilot and boat to follow you and the tides and currents have to be right. If the weather's bad, you just have to go away and come back another day.

After several 'weather cancelled' days, I finally got a chance on 19th August. It was still 50/50 as to whether we could attempt a crossing but time was running out, so we went for it." Julie set off from Shakespeare Beach in Dover and swam the 23-odd miles to Cap Gris Nez in France. "It was very choppy and I remember the feeling of being tossed around in mid-Channel," said Julie. "It was also scary, because you've got these huge big tankers passing quite close to you and because of the late start, I also ended up finishing the swim in darkness, which was weird – I'd never swum in the sea at night before! I went through a few tired phases, but I managed to keep positive. Actually, after several hours you tend to lose all conception of time – you're in a sort of meditation-like state." Just ten hours and nine minutes later, 15-year old Julie waded ashore in France having smashed the British Junior record – one that she still holds to this day.

## The driving force

What has driven Julie to perform her amazing open water feats? She explained, "Battling against the wind and the waves is so much more exciting and yes, I suppose there's an element of danger to it. When you're out there on a vast stretch of water, you have to accept that you're not as safe as in the pool. But then an element of danger is what gives adventure sports their sense of adventure isn't it? I'd recommend open water swimming strongly to anyone who's ever thought of giving it a go - to be honest, I can't ever imagine a time when I won't be out there, swimming across some open water somewhere!"

## Strength to strength

Julie went from strength to strength. The following year she completed the 31.5 mile 3-way swim of Windermere, becoming the first woman to actually do it and setting the fastest time in the process. A few weeks later she swam Loch Lomond, setting a new record of 12 hours 44 minutes. The next year saw Julie swim a 4-way Windermere and also bagged Ullswater, Windermere and Coniston in one day, setting records for each!

In 1991 after a career break, Julie met a Canadian swimmer who'd done some ultra-swims using butterfly and she began to set about tackling some of her old Lake District swims using fly, setting new records along the way. Inevitably though, the thought of attempting the English Channel with butterfly bubbled to the surface and refused to go away. After several years and failed attempts, she finally achieved her dream by a butterfly crossing of the Channel in a world record of 14 hours 18 minutes. She also bagged the world relay records for the first women's team to do a two-way crossing and a three-way crossing – that's around 80 miles, not bad for someone who's scared of jellyfish!

Julie's exploits in the open water continue to this day. In 2005, she only just missed setting a record by swimming the 28.5 miles around Manhattan Island (thwarted by the tail end of Hurricane Dennis!), Meanwhile, earlier this year, she stepped ashore at Lake Taupo, New Zealand's largest lake after her relay team clocked up 120km, the longest ever recorded relay swim setting yet another world record.