Biathlon Canada Long Term Athlete Development

Biathlon Canada

Volume 2: Biathlon Canada LTAD Program

Podium Planning for Performance in Biathlon

Volume 2: Biathlon Canada LTAD Program

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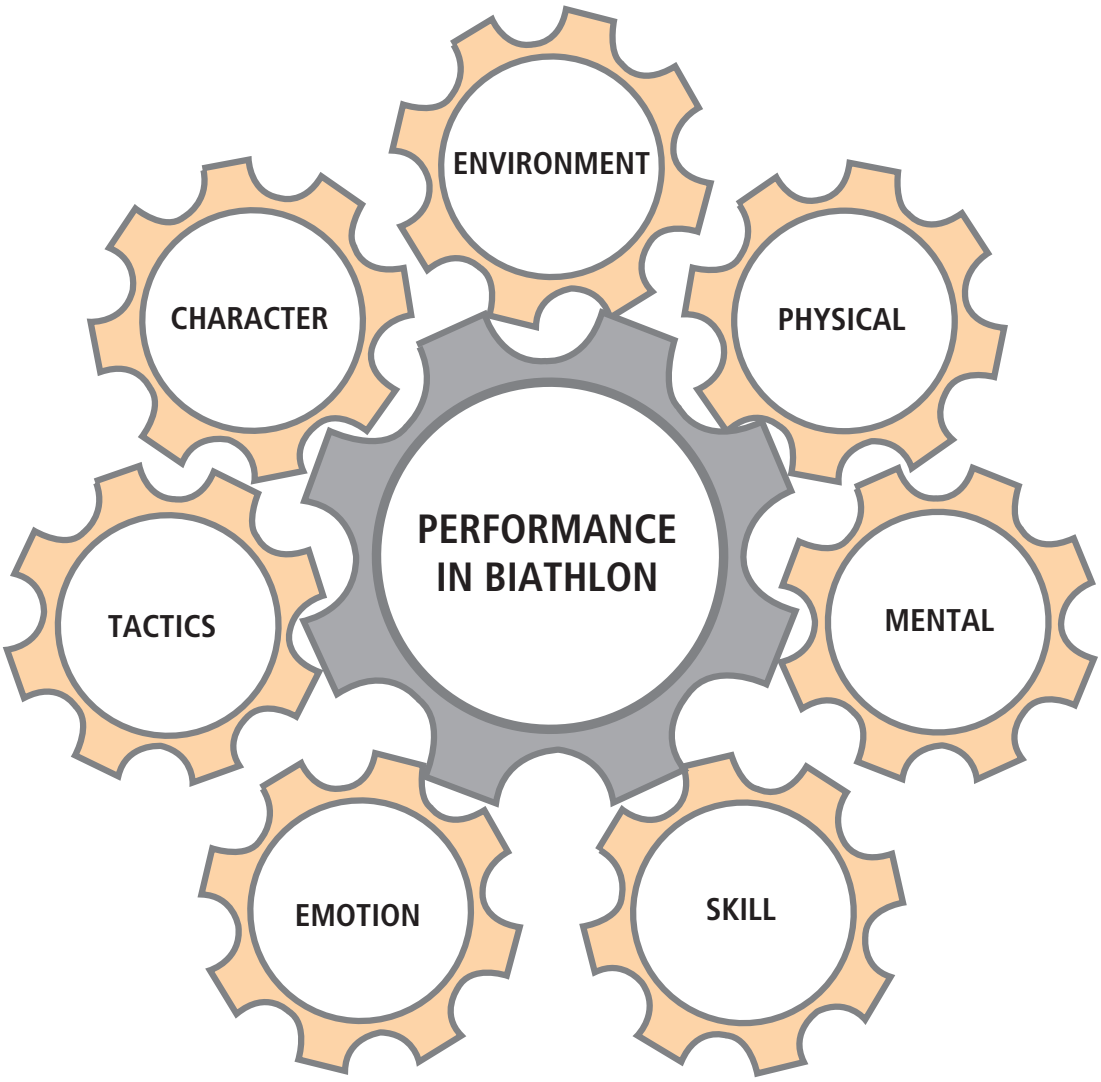
Volume 2: Biathlon Canada LTAD Program Contents

Introduction

Volume 1 of the Biathlon Canada LTAD Model provides the research background and the theoretical foundation for long-term athlete development, filtered for the context of Biathlon. Volume 2 is the expression of Volume 1's principles in a concrete program model, which sets the parameters for program design by Biathlon coaches in Canada. The program model, LTAD-P, provides the practical framework within which to develop athletes graduating from the Learn to Train phase into the competitive environment of the Train-to-Train phase and beyond.

As previously stated, Biathlon is a late developing endurance sport with a high mental component and contrasting skill content. Participants take many years to develop into mature performers based on a myriad of interrelated characteristics.



Whole Athlete Model, adapted from Istvan Bayli, 2004

The following practical model provides a systematic approach to athlete development, based on four crucial pillars of performance: physical, technical, mental and tactical elements of long-term plans.

Tables are provided for physiological, technical and mental development as well as for athletic skills, shooting skills and skiing skills. The sequence and timing of training are based on the information available on the developmental sequences reviewed in Volume 1. Tactics are treated as integral parts of the technical and mental programs as tactics requires particular attention within each of these contexts as tactical ability develops as a highly individualized aspect of an athlete's program.

These tables provide the optimal timetable and framework for the Long-Term Athlete Development Program (LTAD-P)

Long Term Physical Development: Pre PHV

The Long Term Plan for Physical Development presented on this page represents an ideal toward which sport participants, coaches and club programs should strive to attain to ensure the highest proportion of inclusiveness possible. Childhood participants in sport require a level of satisfaction that is derived from enjoyment more than from success although this is important. The goal here is not to attain high-level performance but to expose all participants to an enjoyable, semi structured environment that will stimulate the social technical and physical growth of all involved. Success = enjoyment.

Phase	Guidelines for implementing a sport program
FUNdementals Early and Mid Childhood (from 5-9 years)	**Multi-Sport Exposure:** A primary objective over this time is to expose the child to a variety of sport stimuli. This will develop the different neurological pathways in the Central Nervous System that will be retained for future specialization. Highly technical sports are significantly more challenging to children and may be too demanding for the enjoyment factor. Emphasis must be on play, not competition and should not always be structured. Park play with friends is a crucial element of psycho social and motor skill development. Exposure to Biathlon and Cross-Country Skiing can be achieved by enrolling the child in Biathlon Bears or Jackrabbit ski programs. Over this timeframe it is recommended that the following sports be included with periodical participation: **Gymnastics** (kinesthetic awareness, motor skill and CNS development) **Swimming** (life skill, cardiovascular and strength orientation and non-weight bearing) **Soccer** or other team running jumping sport (main coordinative abilities, life skills, team environment for social skill development) Early specialization in endurance sport can lead to disinterest or burn-out.
Learn-to-train Late Childhood and Pre PHV adolescents (from 9-13 years)	**Biathlon:** Association with a Biathlon Club program is recommended. Ski and Biathlon Clubs should attempt partnerships (Cooperative Sport Development) to associate their programs with other sport clubs in their locale, e.g. Track and Field, Soccer, in order to provide a variety of structured, stimulating, appropriate and fun sport environments. This type of variety will extend the holistic approach to development and decrease early burnout occurrences. It may also reduce some of the workload for the club biathlon and ski coaches. Spring Some Precision Shooting Association with a track or gymnastics club Other sport at the choice of the participant (enjoyment) Summer Precision Shooting 2-3 x weekly Association with a soccer club Other sport at the choice of the participant (enjoyment) Fall Shooting as part of a club Biathlon program (Bears or other). Association with a swimming club Winter Specific club on-snow training program Other sport at the choice of the participant (enjoyment)

Long Term Physical Development: Post PHV

The Long Term Plan for Physical Development presented on the following pages represents an ideal (model) program toward which athletes and coaches should strive when the ultimate goal is attaining high-level international results. It is considered very important that in the early stages of this development process, (particularly for the initial years in the Train-to-Train Phase), training and preparation continues to be based on a multi-sport exposure plan. Emphasis in these early years is placed on the development of technical skills, kinesthetic sense and muscular coordination.

Before using these tables it is essential that you complete a comprehensive pre-season assessment to determine your athletes' training age and level of ability. Once you have determined their capabilities you will be able to set the number of hours and the type of training they require to progress effectively. The tables are a guide to establishing training parameters for a given athlete. More detailed information on physical training plans and integration of the shooting program can be found in the Biathlon Canada Coaching Manual (Chapter 5, Training Program Design and Chapter 4, Shooting).

A common understanding and definition of terms, such as training zones, the principles underlying these tables and the characteristics of the model, is crucial to the application of this program. Most of the critical terms are addressed below:

Training Age. It is essential that the chronological age of individuals be correlated to the onset of Peak Height Velocity. The age at Peak Height Velocity is defined in these tables as PHV1. All of the tables are referenced to PHV1, year one of Post-PHV training. The coach must use the chronological age of PHV1 when applying these tables to individual athletes.

Gender. For the Train-to-Train Phase, training parameters are still common to male and female athletes as differences in physical maturation are only beginning. Athletes included in this phase remain full time students. Males, particularly early maturers, tend to be on the high end of the range for most parameters.

Multi-Sport Exposure. As discussed in Volume 1, in the initial years of the Train-to-Train Phase, training and preparation continues to be based on a multi-sport exposure plan. The total physical hours must include other physical activities such as school inter-mural sports, cross-country running or track, soccer, hockey, ballet, gymnastics, break dancing or other physical activities that improve muscular coordination and kinesthetic senses. Athletes in the early phases of development should be discouraged from specialization.

Specificity. By year 3 (PHV3) or at latest 4 (PHV4) at the end of the Train-to-Train stage, physical hours should be biathlon specific and require daily monitoring to ensure proper progression.

Periodization. The annual plan should include single peaks during the Train-to-Train stage, double peaks in the Train to Compete stage, and may involve multiple or sustained peak periods in the Train to Win stage.

Les Clegg

Definition of Training Zones for Cardiovascular Training

The following table is a guide to standardizing current methodologies and/or terminologies for assessing effort in cardio-vascular training.

Training Zone	Energy system	Type of work	Perceived exertion and characteristics	Rate of perceived exertion (RPE Rushall)	Blood Lactate (mmol/l)	% of Max Heart Rate
Recovery	Aerobic (Recovery)	Continuous, sub-aerobic threshold	Very easy, recovery	9-10	1.0-1.5	< 65%
1	Aerobic (Capacity)	Continuous, near or at Aerobic Threshold	Easy Able to talk easily while exercising	11	< 2.0	60-75%
2	Aerobic (Capacity)	Continuous, sub Anaerobic Threshold	Easy Has difficulties in maintaining an active discussion towards the end of the workout	12-13	2.0-3.5	70-80%
3	3A Aerobic (Power)	Continuous or interval Near or at Anaerobic Threshold (work:rest ratio of 1:2 or less)	Medium Able to speak in phrases Timing enforced by breathing rhythm	14-15	3.5-5.0	80-85%
	3B Aerobic (Power)	Intervals (work:rest ratio of 1:2 or less) Maximum oxygen uptake At or slightly above Anaerobic Threshold	Hard Speaking difficult except in short words	14-15	4.0-6.0	85-90%
4	Anaerobic Lactic (Capacity)	Interval up to 90 seconds (work:rest ratio of 1:2 to 1:4) Lactate tolerance. Work is above Anaerobic Threshold	Hard Very difficult to speak	16-17	6.0-9.0	90%+
5	5A Anaerobic Lactic (Power)	Short Interval up to 30 seconds (work:rest ratio of 1:4 to 1: 8) Lactate Power, Work is above Anaerobic Threshold	Hard No speaking	18-19	Initially low, prolonged training will lead to high blood lactates (6.0+)	90%+ Variable according to muscle group focus and high work: rest ratio
	5B Anaerobic Alactic	Maximum power output for short duration of work time (< 15 seconds). Work:rest ratio is high 1:8 +	Explosive sprinting Demands intense focus, concentration and effort on task	18-19	Low due to high work: rest ratio	

Definition of Strength Training Parameters

The following table is a guide to assist in standardizing current methodologies and/or terminologies for assessing effort in strength training.

Strength category	Definition	Type of work	Examples	Periodization characteristics
Functional strength	Endurance based work involving specific ski movement, imitation or the involvement of body mass movement	Continuous aerobic; using guidelines from the definition of training zones for cardio vascular training	Roller ski/on-snow ski strength (continuous, double pole, legs only) Roller ski/on-snow ski strength (interval, double pole, legs only) Imitation bounding Roller board, vasa trainers, double pole machine Circuit training with ski specific movements Plyometrics	Some coaches will prefer to quantify this as part of aerobic and anaerobic training. Appropriate for optimizing strength gain transfer to ski specificity Most appropriate form of strength training for elite athletes displaying appropriate relative strength level for skiing Participant must acquire efficient technique before using roller-ski or on ski strength All year round activity using energy systems plot to determine appropriate form of workout
	Endurance-Power (speed) based work involving speed within the specific ski movement, imitation or the involvement of body mass movement	Interval; aerobic and anaerobic; using guidelines from the definition of training zones for cardio vascular training		
Endurance strength	Not limited to but generally Weight room based, consisting of light and repetitive work with sets of 14+ repetitions. For muscle hypertrophy use sets of 10-12 repetitions	Weight room Circuit training	Weight room strength training guidelines May be used with crossover to functional strength through circuit training	May be used to transition from power to functional strength. Helps to develop proper lifting techniques in the weight room with novice athletes Develops the contraction of the muscle fibre in an oxidative state generally non ski-specific Generally mid to late dryland, except for hypertrophy which precedes max strength training in early season
Power strength	Weight room based, consisting of sets of 10-12 repetitions involving explosive movement (using approximate weight of 40% of 1 RM)	Weight room Circuit training	Weight room strength training guidelines and circuits	Develops neurological firing of muscles and rapid non – ski specific movement. Trains muscle fibre to contract explosively Generally mid to late dryland with potential micro loads throughout the year
Max Strength	Weight room based, consisting of sets of 1-8 repetition and 100% maximum weight accordingly	Weight room	Weight room strength training guidelines	To be utilized only once optimal PHV in female athletes and post optimal (+6 months) PHV with male athletes is displayed Develops significant non ski specific strength gains to be later developed into ski propulsion movements Generally early dryland (post hypertrophy, anatomical adaptation. Potential micro loads throughout the year

Training to Train

ACBQ

Training to Compete

ACBQ

Training to Win

Christian Manzoni

Training to Train Phase – All Athletes

Age chrono/ Training	Training Volume		Cardiovascular Training				Strength Training		
	Physical	Shooting	Aerobic Capacity	Aerobic Power	Anaerobic Lactic	Anaerobic Alactic	General	Maximal	Power
PHV1 13 years or 1 year	200 hrs to 250 hrs	4000 bullets + 40 hours Dry firing	80% of the YTP	10-15% to include 6-10 races regional / prov.	None	1% Neuromuscular Adaptation + Pre-race Activation + Circuit Training	6-10% Circuit Training Body Weight + ski specific	None	None
PHV2 14 years or 2 years	250 hrs to 300 hrs	5000 bullets + 45 hours Dry firing	75-80% of the YTP	12-15% to include (pre-comp phase) + 8-12 races regional / prov.	Introduction	1% Neuromuscular Adaptation + Pre-race Activation + Circuit Training	10-15% Weight Room Adaptation (2-4 weeks) + 4-6 wk programs + ski specific	None	None
PHV3 15 years or 3 years	300 hrs to 350 hrs	6000 bullets + 50 hours Dry firing	75-80% of the YTP	12-15% to include (specific phase) + 12-15 races regional / prov.	1-2% (pre-comp phase)	1% Neuromuscular Adaptation + Pre-race Activation	10-15% Weight Room Adaptation (3-4 weeks) + 6-8 wk programs + ski specific	None	None
PHV4 16 years or 4 years	350 hrs to 400 hrs	7000 bullets + 60 hours Dry firing	75-80% of the YTP	12-15% to include 12-15 races prov. / Cdn Cup Nationals	1-2% (pre-comp phase)	1% Neuromuscular Adaptation + Pre-race Activation	10-15% Weight Room Adaptation (3-4 weeks) + 8-12 wk programs + ski specific	None	None

Training to Compete Phase – Male Athletes

Age Chrono/ Training	Training Volume		Cardiovascular Training				Strength Training		
	Physical	Shooting	Aerobic Capacity	Aerobic Power	Anaerobic Lactic	Anaerobic Alactic	General	Maximal	Power
17/ 5 years	450 hrs to 500 hrs	8000 bullets + 70 hours Dry firing	75-80% of the YTP	10-12% to include 12-15 races prov. / Cdn Cup World Trials + Nat'ls	2-3% 6 wk programs 2 x per week	0-1% Neuromuscular Adaptation + Pre-race Activation	10-12% Weight Room Adaptation (2-3 weeks) + 6-8 wk programs	1-2% Adaptation (2 wk) 4-6 wk programs 2 x per week	1-2% Adaptation (1 wk) 4-6 wk programs 2 x per week
18/ 6 years	500 hrs to 550 hrs	9000 bullets + 80 hours Dry firing	75-80% of the YTP	10-12% to include 13-17 races CC / World Champs + Nationals	2-4% 6 wk programs 3 x per week	0-1% Neuromuscular Adaptation +Pre-race Activation	10-12% Weight Room Adaptation (2-3 weeks) + 6-8 wk programs	2-4% Adaptation (2 wk) 4-6 wk programs 2-3 x per week	2-4% Adaptation (2 wk) 4-6 wk programs 2-3 x per week
19/ 7 years	550 hrs to 650 hrs	11000 bullets + 90 hours Dry firing	75-80% of the YTP	10-12% to include 15-20 races CC / World Champs + Nationals	2-4% 8 wk programs 3 x per week	0-1% Neuromuscular Adaptation + Pre-race Activation	10-12% Weight Room Adaptation (3-4 weeks) + 8-10 wk programs	2-4% Adaptation (1 wk) 6-8 wk programs 3 x per week	2-4% Adaptation (1 wk) 6-8 wk programs 3 x per week
20 / 8 years	600 hrs to 700 hrs	11000 bullets + 100 hours Dry firing	75-80% of the YTP	10-12% to include 18-22 races CC / World Champs + Nationals	2-4% 10 wk programs 3 x per week	0-1% Neuromuscular Adaptation + Pre-race Activation	10-12% Weight Room Adaptation (2 weeks) + 8-10 wk programs	2-4% Adaptation (1 wk) 6-8 wk programs 3 x per week	2-4% Adaptation (1 wk) 6-8 wk programs 3 x per week

Training to Compete Phase – Female Athletes

Age Chrono/ Training	Training Volume		Cardiovascular Training				Strength Training		
	Physical	Shooting	Aerobic Capacity	Aerobic Power	Anaerobic Lactic	Anaerobic Alactic	General	Maximal	Power
17/ 5 years	400 hrs to 450 hrs	8000 bullets + 70 hours Dry firing	75-80% of the YTP	10-12% to include 12-15 races Prov. / Cdn Cup World Trials + Nationals	2-3% 6 wk programs 2 x per week	0-1% Neuromuscular Adaptation + Pre-race Activation	10-12% Weight Room Adaptation (2-3 weeks) + 6-8 wk programs	1-2% Adaptation (2 wk) 4-6 wk programs 2 x per week	1-2% Adaptation (1 wk) 4-6 wk programs 2 x per week
18/ 6 years	450 hrs to 500 hrs	9000 bullets + 80 hours Dry firing	75-80% of the YTP	10-12% to include 13-17 races CC / World Champs + Nationals	2-4% 6 wk programs 3 x per week	0-1% Neuromuscular Adaptation + Pre-race Activation	10-12% Weight Room Adaptation (2-3 weeks) + 6-8 wk programs	2-4% Adaptation (2 wk) 4-6 wk programs 2-3 x per week	1-2% Adaptation (2 wk) 4-6 wk programs 2-3 x per week
19/ 7 years	500 hrs to 600 hrs	11000 bullets + 90 hours Dry firing	75-80% of the YTP	10-12% to include 15-20 races CC / World Champs + Nationals	2-4% 8 wk programs 3 x per week	0-1% Neuromuscular Adaptation + Pre-race Activation	10-12% Weight Room Adaptation (3-4 weeks) + 8-10 wk programs	2-4% Adaptation(1 wk) 6-8 wk programs 3 x per week	2-4% Adaptation (1 wk) 6-8 wk programs 3 x per week
20/ 8 years	550 hrs to 650 hrs	11000 bullets + 100 hours Dry firing	75-80% of the YTP	10-12% to include 18-22 races CC / World Champs + Nationals	2-4% 10 wk programs 3 x per week	0-1% Neuromuscular Adaptation + Pre-race Activation	10-12% Weight Room Adaptation (2 weeks) + 8-10 wk programs	2-4% Adaptation (1 wk) 6-8 wk programs 3 x per week	2-4% Adaptation (1 wk) 6-8 wk programs 3 x per week

Training to Win Phase – Male Athletes

Age Chrono/ Training	Training Volume		Cardiovascular Training				Strength Training		
	Physical	Shooting	Aerobic Capacity	Aerobic Power	Anaerobic Lactic	Anaerobic Alactic	General	Maximal	Power
21/ 9 year	650 hrs to 750 hrs	12000 bullets+ 110 hours Dry firing	70-75% of the YTP	10-12% to include 18-22 races Europa Cup / Nationals	2-4%	>1% Neuromuscular Adaptation + Pre-race Activation + Taper	6-8% Weight Room Adaptation (1 week) + 8-12 wk programs+ ski specific	2-4% Adaptation (1 wk) 4-6 wk programs 3 x per week	2-4% Adaptation (1 wk) 4-6 wk programs 3 x per week
22/ 10 years	700 hrs to 800 hrs	13000 bullets+ 110 hours Dry firing	70-75% of the YTP	10-12% to include 18-24 races WC / WCh / Nat'ls	2-4%	>1% Neuromuscular Adaptation + Pre-race Activation + Taper	6-8% Weight Room Adaptation (1 week) + 8-12 wk programs + ski specific	2-4% Adaptation (1 wk) 4-6 wk programs 3 x per week	2-4% Adaptation (1 wk) 4-6 wk programs 3 x per week
23/ 11 years	700 hrs to 800 hrs	14000 bullets+ 120 hours Dry firing	70-75% of the YTP	11-13% to include 18-24 races WC / WCh / Nat'ls	2.5-4%	>1% Neuromuscular Adaptation + Pre-race Activation + Taper	6-8% Weight Room Adaptation (1 week) + 8-12 wk programs + ski specific	1-3% Adaptation (1 wk) 3-6 wk programs 2-3 x per week	3-5% Adaptation (1 wk) 6-10 wk programs 3-4 x per week
24/ 12 years Olympic year	650 hrs to 800 hrs	15000 bullets+ 120 hours Dry firing	70-75% of the YTP	12-15% to include 18-24 races WC / OWG / Nat'ls	3-4%	>1% Neuromuscular Adaptation + Pre-race Activation + Taper	6-8% Weight Room Adaptation (1 week) + 8-12 wk programs + ski specific	1-3% Adaptation (1 wk) 3-6 wk programs 2-3 x per week	5-7% Adaptation (1 wk) 8-12 wk programs 3-4 x per week

Training to Win Phase – Female Athletes

Age Chrono/ Training	Training Volume		Cardiovascular Training				Strength Training		
	Physical	Shooting	Aerobic Capacity	Aerobic Power	Anaerobic Lactic	Anaerobic Alactic	General	Maximal	Power
21/ 9 year	600 hrs to 650 hrs	12000 bullets+ 110 hours Dry firing	70-75% of the YTP	10-12% to include 18-22 races Europa Cup / Nationals	2-4%	>1% Neuromuscular Adaptation + Pre-race Activation + Taper	6-8% Weight Room Adaptation (1 week) + 8-12 wk programs+ ski specific	2-4% Adaptation (1 wk) 4-6 wk programs 3 x per week	2-4% Adaptation (1 wk) 4-6 wk programs 3 x per week
22/ 10 years	650 hrs to 700 hrs	13000 bullets+ 110 hours Dry firing	70-75% of the YTP	10-12% to include 18-24 races WC / WCh / Nat'ls	2-4%	>1% Neuromuscular Adaptation + Pre-race Activation + Taper	6-8% Weight Room Adaptation (1 week) + 8-12 wk programs+ ski specific	2-4% Adaptation (1 wk) 4-6 wk programs 3 x per week	2-4% Adaptation (1 wk) 4-6 wk programs 3 x per week
23/ 11 years	650 hrs to 750 hrs	14000 bullets+ 120 hours Dry firing	70-75% of the YTP	11-13% to include 18-24 races WC / WCh / Nat'ls	2.5-4%	>1% Neuromuscular Adaptation + Pre-race Activation + Taper	6-8% Weight Room Adaptation (1 week) + 8-12 wk programs+ ski specific	1-3% Adaptation (1 wk) 3-6 wk programs 2-3 x per week	3-5% Adaptation (1 wk) 6-10 wk programs 3-4 x per week
24/ 12 years Olympic year	600 hrs to 700 hrs	15000 bullets+ 120 hours Dry firing	70-75% of the YTP	12-15% to include 18-24 races WC / OWG / Nat'ls	3-4%	>1% Neuromuscular Adaptation + Pre-race Activation + Taper	6-8% Weight Room Adaptation (1 week) + 8-12 wk programs+ ski specific	1-3% Adaptation (1 wk) 3-6 wk programs 2-3 x per week	5-7% Adaptation (1 wk) 8-12 wk programs 3-4 x per week

Training Volume Progressions

The following table illustrates the distribution of various parameters for Biathlon training throughout the development continuum.

Parameter	T2T1 PHV1	T2T2 PHV2	T2T3 PHV3	T2T4 PHV4	T2C1 Year 5	T2C2 Year 6	T2C2 Year 7	T2C4 Year 8	T2W1 Year 9	T2W2 Year 10	T2W3 Year 11	T2W4 Year 12
Training weeks committed to Biathlon	30	40	40	40	44	44	48	48	50	50	50	50
Ratio general vs. specific training	60/40	60/40	50/50	50/50	50/50	45/55	45/55	40/60	40/60	40/60	30/70	30/70
Physical training days per week	3	4-5	5	5	5-6	6	6	6-7	6-7	6-7	6-7	6-7
Total annual physical Training hours: Male Training hours Female	200-250	250-300	300-350	350-400	450-500/ 400-450	500-550/ 450-500	550-650/ 500-600	600-700/ 550-650	650-750/ 600-650	700-800/ 650-700	700-800/ 650-750	650-800/ 600-700
Shooting training days per week	3	3	4	4	5	5	5	5	5-6	5-6	5-6	5-6
Number of bullets annually	4000	5000	6000	7000	8000	9000	11000	11000	12000	13000	14000	15000
% of total bullets as precision shooting (without physical load)	70	66	60	56	55	54	54	53	52	52	52	52
% total bullets as Z1-Z2 intensity combo	20	22	25	28	28	28	28	28	28	28	28	28
% total bullets as Z3-Z4 intensity combo	8	8	11	12	13	13	13	13	14	14	14	14
% total bullets used in competition shooting	2	4	4	4	4	5	5	5	6	6	6	6
Dry firing training hours annually	40	45	50	60	70	80	90	100	110	110	120	120
% dry firing annually for precision and position drills	70	65	60	60	55	55	55	55	55	55	55	55
% dry firing annually for range drill, speed exercises	30	30	40	40	45	45	45	45	45	45	45	45

Training Mode Progressions

These parameters are given in total % of training hours, excluding biathlon competitions (or cross country competitions). Allowing for this, the specific ratio in this table will be slightly lower than the overall general:specific ratio, given in the Training Volume Progressions table above.

Training Mode	T2T 1-2 PHV 1-2	T2T 3-4 PHV 3-4	T2C 1-2 Year 5-6	T2C 3-4 Year 7-8	T2W 1-2 Year 9-10	T2W 3-4 Year 11-12
XC Ski – Skating (dryland and on snow)	25	30	30-35	35	35-40	40
XC Ski – Classic (dryland and on snow)	10	10	10-12	10	12	15
Continuous double poling (dryland and on snow)	2.5	2.5-5	5	5	3	3
Continuous skating without poles (dryland and on snow)	2.5	2.5-5	5	5	3	3
Bounding, jumping, games	2.5-5	2.5-5	5	5	3	3
Running	15	15	15	15	12-15	10-12
Cycling	15	12	12	10	10	8-10
Strength (max, power, endurance)	10-15	12-15	15-18	15-18	10-15	10-15
Other cross training	5-10	5-7.5	2.5-5	2.5	<2.5	<1

Comparative Analysis of Intensity and Strength Training Loads During Development: Male Athletes

Stage	Low end hours from model	Low end % AeP from Model	Equivalent AeP in hours	Low end % Anaerobic from Model	Equivalent Anaerobic hours	Low end % Strength	Equivalent Hours strength	Total Intensity hours	Total intensity/ strength hours combined
PHV1	200	10%	20	0%	0	6%	12	20	32
PHV2	250	12%	30	0%	0	10%	25	30	55
PHV3	300	12%	36	1%	3	10%	30	39	69
PHV4	350	12%	42	1%	3.5	10%	35	45.5	80.5
T2C1	450	10%	45	2%	9	12%	54	54	108
T2C2	500	10%	50	2%	10	14%	70	60	130
T2C3	550	10%	55	2%	11	14%	77	66	143
T2C4	600	10%	60	2%	12	14%	84	72	156
T2W1	650	10%	65	2%	13	10%	65	78	143
T2W2	700	10%	70	2%	14	10%	70	84	154
T2W3	700	11%	77	2.5%	17.5	10%	70	94.5	164.5
T2W4	700	12%	84	3.0%	21	12%	84	105	189

Notes:

1. The drop in equivalent hours strength in the T2W phase is offset by an increase of functional strength as a year round activity built into physiological training intensity and as part of aerobic training.

2. Drop in combined intensity and strength hours in years 1 and 2 of T2W phase is a product of less weight room strength but there is an overall increase in intensity hours and functional strength embedded in other training modes.

Comparative Analysis of Intensity and Strength Training Loads During Development: Females Athletes

Stage	Low end hours from model	Low end % AeP from Model	Equivalent AeP in hours	Low end % Anaerobic from Model	Equivalent Anaerobic hours	Low end % Strength	Equivalent Hours strength	Total Intensity hours	Total intensity/ strength hours combined
PHV1	200	10%	20	0%	0	6%	12	20	32
PHV2	250	12%	30	0%	0	10%	25	30	55
PHV3	300	12%	36	1%	3	10%	30	39	69
PHV4	350	12%	42	1%	3.5	10%	35	45.5	80.5
T2C1	400	10%	40	2%	8	12%	48	48	96
T2C2	450	10%	45	2%	9	14%	63	54	117
T2C3	500	10%	50	2%	10	14%	70	60	130
T2C4	550	10%	55	2%	11	14%	77	66	143
T2W1	600	10%	60	2%	12	10%	60	72	132
T2W2	650	10%	65	2%	13	10%	65	78	143
T2W3	650	11%	72	2.5%	16.5	10%	65	88.5	153.5
T2W4	650	12%	78	3.0%	20	12%	78	98	176

Notes:

1. The drop in equivalent hours strength in the T2W phase is offset by an increase of functional strength as a year round activity built into physiological training intensity and as part of aerobic training.

2. Drop in combined intensity and strength hours in years 1 and 2 of T2W phase is a product of less weight room strength but there is an overall increase in intensity hours and functional strength embedded in other training modes.

Learning occurs on a continuum from introduction to mastery, as represented by the four stages described below. In addition to instruction and modeling, effective monitoring of progress is vital to ensuring progression and proficiency in skill acquisition. The Long Term Plan for Skiing Development is based on a four step progression:

- Skill Acquisition,
- Skill Development,
- Skill Refinement, and
- Tactical Use

These four stages are not associated with any particular age (chronological or physiological) as mastery of technique is not determined by age. Of course older athletes and particularly athletes with prior exposure to other sliding-balance sports, or sports which demand a highly developed kinesthetic sense, may progress very rapidly through the skiing skills progression. The information below is organized almost completely by competence progression, not on age or physical growth parameters. However, for the majority of participants, the skiing progressions will start in Mid to Late Childhood with Skill Acquisition, as described in the LTAD Model.

Skill Development, Facilitation

Facilitators will incorporate all domains of learning into ski instruction and practice planning:

- Psychomotor/kinaesthetic - the physical act of performing the skill and its components,
- Cognitive - knowledge about the skill and its use,
- Affective - the social aspect of learning, including self-esteem, friendship, team work, etc.
- Play – especially in the skill acquisition and skill development Vstages.

Skill Acquisition

Typically, skiing skills will be acquired over a 4-5 year period. Beginners aged 8, 12, 14 or older will progress at different rates and will respond to different teaching techniques. The rate of progress expected and the approach to learning facilitation must be based on considerations of maturation stage, experience, ability, dedication, time and facilities available, parental support, etc. Sound teaching principles for addressing various learning styles and age group characteristics must be used to ensure continued development (See Volume 1: Appendix 2 and Biathlon Canada Coaching Manual - Chapters 2 & 3).

Skill Development

Skill development requires practice, practice, and more practice. Athletes need opportunities to utilize their skills in drill, recreation and competition. An appropriately qualified coach or instructor should lead technical sessions. Effective analysis and feedback is required to facilitate improvement of skills. Video analysis and skilled modeling are essential ingredients in the skill development stage programs.

Skill Refinement

Skill refinement is the optimization of primary skill components to suit individual differences. Generally this will follow once athletes have achieved level 4 (below). Athletes need opportunities to experiment with their skills in varied performance environments. This is the phase where athletes become experts. It is the phase where technique innovation may be expected.

Tactical Skill Use

This is the application of particular skills to solving the various challenges of locomotion on skis. In Biathlon, the matching of ski skills to terrain, race-tactics, and physical, physiological and mental capabilities is necessary to optimize performance. Athletes must learn to make effective use of their full array of skills to optimize their performance in competition. Tactical use of skills can be learned gradually and in parallel with increasing technical proficiency and/or changing performance context.

Skill Development vs. Developmental Phase

	FUNdamentals	Train to Train	Train to Compete	Train to Win
Development Continuum	Skill Acquisition			
	Skill Development	Skill Development	Skill Development (early in phase)	
		Skill Refinement for early skills	Skill Refinement for all skills	Skill Refinement (detailed)
	Match technique to terrain	Develop tactical use in competition	Develop and refine tactical use	Refine Tactical Use
Location for Delivery	Biathlon Bears			
	Cadet Biathlon	Cadet Biathlon		
	Club Beginner	Club Development Programs	Club HP Program	
		Provincial Development Programs	Provincial High Performance Programs	
			National Jr. Teams and training centers	Nationals Sr. Teams and training centers

Long Term Skiing Development

The program model provided in the tables that follow specifies reasonable and effective timelines and generic standards for ski skill development. Detailed information on ski skill instruction, such as skill progressions, drills and specific training methodologies are provided in the Biathlon Bears Skiing Manual and the Biathlon Canada Coaching Manual. The Cross-Country Canada Coaching Manuals are another excellent source of instructional material.

Ski Skill Acquisition: Overview

Skill	Year 1	Year 2	Year 3	Year 4	Year 5 +
Falling and Rising	3	4			
Star turn	3	4			
Walk on skis	3	4			
Glide, one leg, hop	3	4			
Snow plow braking	3	4			
Glide on one ski in track	2	3	4		
Glide, 2 skis, down hill tuck	2	3	4		
Snow plow turn	2	3	4		
Skid turn	2	3	4		
Gliding, sideways hop	2	3	4		
Gliding, forwards hop	2	3	4		
Diagonal stride	2	3	3	4	
Parallel turn	1	2	3	4	
Step turn	1	2	3	4	
Parallel stop	1	2	3	4	
Double pole	1	2	3	4	
Free skate	1	2	3	4	
One skate	1	2	3	4	
Two-skate	1	2	3	4	
One-step double pole		2	3	4	
Offset-skate		2	3	4	
Skill transitions		2	3	4	
Terrain analysis		1	2	3	4
Course segmentation		1	2	3	4
Tactics for simultaneous/pursuit starts					3

Scores, 1-4 represent performance abilities. For children, the numbers represent the level of performance one can expect, given the developmental patterns reviewed throughout Volume 1.

1 = Skill recognizable; 2 = Basic execution and timing correct; 3 = Skill well developed; picks appropriate technique as needed; 4 = Skill execution fluid; produced on demand; ready to be polished to elite standards.

Technical Standards for Ski Skills Acquisition

Skill	Technical Standards				
	Year 1	Year 2	Year 3	Year 4	Year 5+
Falling and rising	Untangles equipment and places skis across fall line before rising.	Quickly recovers from falls on hills and flats.	Rarely needs these skills.		
Star turn	Turns in both directions; shows signs of imbalance during turn.	Completes turn, quickly and smoothly without faltering or losing balance.			
Walk on skis	Shows obvious weight shift but needs arms out for additional balance.	Can walk fast; arms used primarily for propulsion.			
Glide on one ski in track	Holds balance for short periods; length of glide is short (1m plus).	Can hold glide for 2-3 m with full weight shift.	Can hold glide for 5 m plus on downhill; with full weight shift.	Out of track. Can hold glide for 5 m plus on downhill; with full weight shift.	
Glide, one leg, hop	Balance with arms out; landing on the hop is unstable.	Stable landing; both legs; multiple repeats.			
Snow plow braking	Used as automatic response to the need to stop or slow down.	Ability to stop rapidly on steep hills.			
Glide, 2 skis, down hill tuck	Skis parallel in track; ankles and knees flexed; poles tucked under arms.	In or out of track. Skis parallel; lower, more compact position.	In track. Ankles and knees bent, elbows on top of knees, hands in front of face, back horizontal.	In or out of track. Skis parallel, ankles and knees bent, elbows on top of knees, hands in front of face, back horizontal.	
Snow plow turn	Turning under control on easy hill. Can link two consecutive turns at slow speed.	Can turn in control on moderate hill. Can link several consecutive turns and stay in control.	Linked turns on steep hill (Alpine blue square run).		
Skid turn	Skis skid but not parallel; returns to snowplow if out of control on moderate hill.	Controlled turns with skis edged on moderate hills. Maintains good 'ready' position.	Edges carving. Uses as automatic response to stop quickly or make a quick change in direction.		
Gliding sideways hop	Hop 5 – 10 cm sideways on one foot while gliding on flat. Either foot.	Hop sideways, both feet on gentle slope. Hope over 15 cm cone on flat.	One footed take off and landing secure on moderate hill. Jump 15 cm cone on gentle slope.		
Gliding forwards hop	Hop 5 – 10 cm forward on one foot while gliding on flat. Either foot.	Two to three forwards hops on gentle slope; either foot.	One footed take off and landing secure on moderate hill. Land jump off 30 cm bump on moderate slope.		
Diagonal stride	Basic coordination of arms and legs. Can climb gentle slopes.	Distinct weight shift. Arms and legs well coordinated. Good diagonal "neutral" position from video. Climbs moderate slopes with good wax.	Distinct pre-load on kick. Power and follow through on arms. Automatically adjusts stride length to terrain.	Motions coordinated and fluid. Graceful. Adjusts technique to track and wax conditions.	
Parallel turn	Looks like skid turn; skis not consistently parallel; arms out for balance.	Skis mostly parallel; knees flexed; edges beginning to carve. Some linked turns on moderate slope.	Most turns carved. Links 3 – 4 turns at a time. Arm and leg movements well coordinated.	Fluid movements. Turns symmetrical about fall line. Confident on wide moderate slopes (Alpine blue square run).	
Step turn	Shows basic movements at slow speed on flat to gentle slope terrain in wide turns. Like a quick, linear star turn.	Can perform at medium speeds on moderate terrain. Distinctive weight shift between steps. Quick steps. Turns left and right.	Quick, coordinated steps. Can perform well on fast wide downhill turns that are well rehearsed.	Quick, well coordinated steps. Can perform on fast wide downhill turns with little speed loss.	Confident execution in a variety of terrain and snow conditions during competitions. Accelerates out of turns.
Parallel stop	Starts as snowplow turn, lifts inside ski and ends with skis parallel. Stopping point uncertain.	Lifts heels simultaneously to turn across direction of travel. Edges. Stops faster. Often wobbly.	Confident enough to jump into parallel stop. Sometimes crashes out of control.	Quick controlled stops in emergency or when appropriate. Rarely falls while executing.	Confident. No longer uses parallel stop in attempts to intimidate coaches or impress little old ladies.

Technical Standards for Ski Skills Acquisition (con't)

Skill	Technical Standards				
	Year 1	Year 2	Year 3	Year 4	Year 5+
Double pole	Shows recognizable, basic double pole movements. Able to double pole up gentle slope.	Pole plant initiated with upper body. Mostly plants pole with backward slant. Releases pole on follow through. Knees neither locked nor collapsing as body rotates forwards.	Hips over heels at pole plant. Arms remain locked during body rotation. Execution with fast tempo. Weight evenly distributed on both feet. Can double pole up short moderate hill.	Hip joint wide open at beginning of cycle. Hips in front of heels at pole plant. Quick recovery to start position. Upper torso rotates to 80-85°.	Heels, hips shoulders aligned on 60° slant on pole plant, falling forward. Very fast forearm movement at end of poling. Uses lower abdominals to push feet forward at end of poling cycle.
Free skate	Recognizable as free skate. Wide-V; weight in centre; uncoordinated; not powerful. Skis mostly edged.	Narrower V; distinct weight shift; arms and legs coordinated. Mostly flat ski. Relatively upright stance. Jerky.	Narrower V. More stable; longer glide phase; good leg extension; complimentary arm action; more forward commitment.	Legs like a speed skater; upper body straight down track, arm swings providing coordinated forward momentum. Smooth.	Able to skate from tuck at bottom of down hills or on moderate slopes.
One skate	One poling movement per skate. Timing poor. Skating movements truncated to accommodate uncertain balance. Staccato.	Body position and balance improved with increased glide, slower turnover rate. More complete poling and leg actions.	Can 1-skate as low tempo cruise or high tempo for acceleration. Narrow V. Strong forward momentum on double pole, initiated with upper torso.	Movements quick, powerful and coordinated. Uses 1-skate to power up short sharp hills. Very narrow V. Small amount of side-to-side movement in CG*.	Arm, torso and leg movements fully coordinated. Graceful. Looks effortless at high speed.
Two-skate	Poling on every other skate. Strongly favours one side, usually the weak balance leg.	Distinct glide phase on poling side before pole plant. See double pole notes for body position. Recognizable 2-skate on weak side.	Skate kick even on both sides. Controls tempo by extending or contracting glide phase. Almost equally strong on both sides. Timing very good.	Switches sides at will via 1-skate. Actions smooth and powerful on both sides. Poling position looks like double pole on video.	Arm, torso and leg movements fully coordinated. Graceful. Looks effortless at high speed.
One-step double pole		Diagonal stride kick followed by double pole. Execution at 2nd year level for both. Favours one leg.	Can kick on both feet. Movements integrating. Execution at 3rd year. Level for both. Distinct weight shift before kick.	Automatically alternates left and right kicks. Slides kicking foot forwards just before weight shift to enhance kick.	Fully coordinated, graceful. Switches back and forth between one-step and diagonal as terrain and wax dictate.
Offset-skate	Three-point landing on pole side. Sometimes falls back into a modified 2-skate. Strongly favours one side. V usually too wide. Skis edge too soon.	Stepping up hills; good leg extension on strong side. Can execute OK on weak side. Quick and light. Flat ski on moderate hills; V more appropriate to terrain.	Heels under hips, CG* over binding, flat ski. Elbows down; torso and shoulders look like double pole at pole plant. Poles mostly offset in proportion to V. Consistent on moderate hills. Offsets on both sides.	V width appropriate to steepness. Pole plant varies with steepness to allow arm follow through with pole release. Technique resistant to fatigue. Can execute hoping-style offset when fresh.	No preferred side. Smooth, graceful, looks effortless on most terrain while maintaining constant velocity.
Skill transitions		Skips one or more poling cycles during technique transitions.	Can transition from One-skate to Two-skate and back without skipping poling cycle.	Changes sides in Two-skate via One-skate. Changes sides easily in Offset on moderate hills.	Can switch sides or technique on command without missing poling cycles 90% of time except under difficult conditions.
Terrain analysis		Understands in principle that each technique is used on particular terrain. Tends to choose favourite technique over appropriate technique.	Chooses appropriate technique most of the time. Transitions not smooth and not at optimum time. Aware of best line principle for corners.	Understands principles of changing gears to maintain optimum velocity. Changes more timely. Tries to take best line through corners.	Transition between techniques smooth. Picks good lines in corners. Monitors interaction between technique, terrain and physiological state.
Course or loop segmentation		Able to describe and discuss parts of loop and technique used after skiing.	Able to ski course with coach and appreciate technique – terrain advice. Executes in practice. Does segmentation plan with help. Can tell war stories with correct jargon.	Needs to work with coach to understand key areas of the course. Makes plan with gentle prompting.	Able to memorize course after 1-2 times through. Good analysis of technique and line to be used in each section. Uses plan for mental rehearsal.
Tactics for simultaneous and pursuit-style starts.				Understands concepts. Mental focus often affected. Technique affected by inappropriate choice of tactics.	Able to choose correct tactics most of the time. Focus and technical ability occasionally affected by circumstances.

* CG = Centre of gravity

Long Term Shooting Development

The long term shooting development plan is presented on the following pages. As previously stated, shooting skills will be acquired over a 5-6 year period as the participant progresses from basic skills to advanced skills.

In the development of each of the skills in relation to the development stage of the participant, performance criteria are developed in this model under four categories: prone position, standing position, mental skills and environmental skills. Detailed information on shooting skill instruction, such as drills, specific training methodologies and shooting periodization are provided in the Biathlon Bears Manual and the Biathlon Canada Coaching Manual (Chapter 4).

Shooting Skill Acquisition: Overview

Shooting Skill	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Basic skills							
Understands sight picture	3	4					
Prone position, with support	3	4					
Aiming process	2	3	4				
Aiming, precision, with support	2	3	4				
Natural alignment, prone	1	2	3	4			
Trigger control	1	2	3	4			
Make sight corrections	1	2	3	4			
Range procedure, non carry	1	2	3	4			
Rifle fit	1	2	2	3	4		
Prone shooting							
Breath control, prone	1	2	2	3	4		
Shooting rhythm, prone	1	2	2	3	4		
Setup time, prone standard	1	1	2	3	4		
Follow through	1	1	2	3	4		
Aiming precision, prone		1	2	3	4		
Prone position, sling		1	2	3	4		
Coping stategies, prone		1	2	3	4		
Five shot sequence, prone		1	2	2	3	4	
Race shooting, prone			1	2	3	4	
Standing shooting							
Standing position			1	2	4		
Natural alignment, standing			1	2	4		
Self zero			1	2	4		
Range procedure, carry			1	2	4		
Race shooting, standing			1	2	3	4	
Advanced skills							
Shot analysis		1	2	2	3	3	4
Light adjust			1	2	3	3	4
Wind adjust			1	2	3	3	4
Aiming off, prone				1	2	3	4
Group analysis				1	2	3	4
Five shot sequence, standing				1	2	3	4
Shooting rhythm, standing				1	2	3	4
Setup time, standing standard				1	2	3	4
Shooting speed standard				1	2	3	4

Scores, 1-4 represent performance abilities. The numbers represent the level of performance one can expect, given the developmental patterns shown above. 1 = Skill recognizable; 2 = Basic execution and timing correct; 3 = Skill well developed; picks appropriate technique as needed; 4 = Skill execution fluid; produced on demand; ready to be polished to elite standards.

Shooting Skill Development: Prone

Skill	Bears	Learning to Train	Train to train	Train To compete	Train To Win
Rifle Fit	Shared rifles. Stock, trigger finger and sights close to fitted.	Minimize shared rifles. Good fit at all contact points. Vertical muzzle jump.	Perfect support and alignment. Frequent verification required due to maturation.	Customized fit.	Customized stock and fit with possible adaptations for speed.
Prone Position	Ground contacts, T-shape, rifle to body angle all correct; skis OK.	Only A's and B's on checklists.	Mostly A's on checklists.	All A's on checklists.	
Sight Picture	Able to achieve good picture with conscious effort.	Always achieves good picture with conscious effort.	Perfect sight picture with less conscious effort.	Perfect sight picture is automated.	
Aiming Process	Coordinates all elements to shoot a 40 mm group (5 rounds).	Coordinates all elements to shoot a 30 mm group (5 rounds).	Shoot 30 mm group (10 rounds).	Shoot 20 mm group or smaller (10 rounds). BS speed < 4 sec/shot.	Shoot 15-20 mm group or smaller (10 rounds). BS speed < 3 sec/shot.
Natural Alignment	Check when reminded; makes adjustment.	Checks regularly and takes time to adjust position.	Checks automatically and adjust position effectively.	Checks unconsciously (feels), seldom requires positional change.	No positional changes required.
Breath Control	Attempts good pattern when reminded. Hold appropriate length.	Regular pattern. Hold mostly appropriate length.	Pattern automated, smooth movement, retries if sight picture is off.	Full control. Hold always coordinated with trigger release and fine aim.	
Trigger Control	Distinguish between squeezing the trigger versus pulling. Attempts to coordinate trigger squeeze with breathing and sight picture.	Successful coordination of trigger squeeze with breathing and sight picture.	Moving towards full automation coordination; smooth release, excellent trigger position, reflexive shot release.	Fully automated shot release.	
Follow Through	Conscious and distinct follow through on most shots.	Sufficient follow through, occasionally forgotten.	Reduced follow through, always performed.	Fully automated minimal follow though.	
Sight Corrections	Requires assistance.	Able to adjust own sights.	Able to self-zero.	Anticipates sight corrections prior to zero.	Fully developed capability to Ability to opt for aiming off.
Rhythm	3-4 breaths per shot. Often aborts.	2-3 breaths per shot. Distinct rhythm. Seldom aborts rhythm.	2 breaths per shot, good consistency for shot-times.	1 breath per shot, consistent shot-times.	1 breath per shot, reduced shot-times from T2C phase.
5-Shot Prone Integration	5 shots safely, Echo-to-Alpha or A to E. Able to count shots.	Pattern across targets consistent. Reload and traverse mostly consistent.	Good groups; few tendencies. Timing between shots consistent.	Tight groups, no tendencies. Automated.	
Prone Range Procedure	Safe, on shooting point only.	Consistent and smooth, on shooting point only.	Fast and efficient, sequence memorized and from the carry position.	Automated and instinctive.	
Prone Scores	65+ / 100, precision 60%+ combo hits on prone targets, 80+ on standing targets from prone.	150+ / 200 precision 60-70%+ combo hits.	170/200 precision 80%+ combo hits.	270/300 precision 90%+ combo hits.	280+/300 precision 90-95%+ combo hits.
Prone Set-up (first shot)		25 - 30 sec, 80% hit rate.	22 - 25 sec, 90% hit rate, recognizes error quadrant.	17 - 20 sec, 95% hit rate, called bullet position.	< 17 seconds.
Prone Shot Times	Able to generate performances at <10 sec/shot prone.	Able to generate performances at < 8 sec/shot prone.	Consistently generates performances at < 5 sec/shot prone.	< 4 sec/shot prone.	2-3 sec/shot prone.
Prone Range time	Emphasis is not on time.	70 sec or less.	45 sec. or less.	30-40 seconds.	27-32 seconds.
Muscle Adaptation	Able to hold for 5 rounds.	Hold for 3 min. prone.	Hold for 5 min. prone.	Hold for 7 min. prone.	Hold for 10 min. prone.

Shooting Skill Development: Standing

Skill	Train to train - Years 1/2	Train to train Years 3/4	Train To compete	Train To Win
Standing Position	Only A's and B's on checklists.	Move towards A's only on checklists.	All A's on checklists.	
Sight Picture	Achieves good picture with conscious effort, but not able to hold sight picture.	Perfect sight picture with less conscious effort.	Perfect sight picture is automated.	Ability to hold perfect sight picture.
Aiming Process	Coordinates all elements to shoot a 110 mm group (5 rounds).	Shoot 90 mm group (10 rounds).	Shoot 70 mm group or smaller (10 rounds).	
Natural Alignment	Checks regularly and takes time to adjust position.	Checks automatically and adjust position effectively.	Checks unconsciously (feels), seldom requires positional change.	No positional changes required.
Breath Control	Regular pattern. Hold mostly appropriate length.	Pattern automated, smooth movement, retries if sight picture is off.	Full control. Hold always coordinated with trigger release and fine aim.	
Trigger Control	Coordinates trigger squeeze with breathing and sight picture.	Good coordination; smooth release, excellent trigger position, reflexive shot release.	Fully automated shot release.	
Follow Through	Sufficient follow through, occasionally forgotten.	Reduced follow through, always performed.	Fully automated minimal follow though.	
Rhythm	Moves towards 2-3 breaths per shot. Distinct rhythm. May abort but will recommence rhythm.	1-2 breaths per shot, good consistency for shot-times.	1 breath per shot, consistent shot-times.	1 breath per shot, reduced shot-times from T2C phase.
Rifle Control	Large and fast wobble. Vertical muzzle jump.	Small, slower wobble. Good rifle holding.	Small slow wobble. Excellent rifle holding.	Able to hold target in sight consistently.
5-Shot Standing Integration	Good natural alignment. Five single shots.	Discernable groups; Reload and traverse mostly consistent.	70mm group, no tendencies. Timing between shots consistent.	Prone groups, no tendencies and reduced time between shots from T2C.
Standing Range Procedure	Initial: Safe, on shooting point only. Moving towards consistent and smooth.	Efficient, memorized and from the carry position.	Fast and efficient sequence, moving towards automated and instinctive.	Fully automated.
Standing Scores	40+ / 100 precision, 60%+ combo hits.	60+ / 100 precision 75-80%+ combo hits.	140+ /200 precision, 85%+ combo hits.	210/300 precision, 90%+ combo hits.
Standing Set-up (first shot)	20 - 25 sec, 80% hit rate, needs feedback about bullet position.	16-20 sec, 90% hit rate, identifies error quadrant.	12 - 16 sec, 90% hit rate and called bullet position.	12 - 15 sec, 95% hit rate and called bullet position.
Standing Shot Times	Able to generate performances at < 6 sec/shot.	Able to generate performances at < 4 sec. per shot.	Consistently generates performances at < 3 sec. per shot.	2-3 sec. per shot.
Standing Range time	65 sec or less	40 sec or less	30 sec or less	22-27 seconds.
Muscle Adaptation	Hold for 2 min.	Hold for 4 min.	Hold for 8 min.	Hold for 10 min +.

Shooting Skill Development: Mental Skills

Skill	Bears	Learning to Train	Train to train	Train To compete	Train To Win
Mental shooting model	Ability to use key skills from the mental shooting model when in the task.	Knows basic 6-step range plan.	Implements basic 6-step range plan.	Detailed written plan, successfully executed Able to adapt program, able to re-focus on demand.	Detailed written plan, successfully executed Able to adapt program to venue and type of competition, able to re-focus on demand.
Concentration	Introduced to concept and importance.	Able to concentrate for several consecutive shots.	Able to concentrate for complete bout and able to manipulate appropriate type of concentration most of the time.	Able to concentrate for complete competition and able to manipulate appropriate type of concentration at will.	Able to concentrate for complete event schedule and automated adaptation to appropriate type of concentration at will.
Attentional control	Introduced to concept and importance.	Focuses attention on shooting process, most shots.	Able to direct attention to correct aspect of shooting plan most of the time.	Able to direct attention to correct aspect of shooting plan 95%+ of the time.	Automatically directs attention to correct aspect of shooting plan for venue and type of competition
Arousal control	Introduced to concept and importance.	Attempts to manage arousal on all bouts.	Manages arousal successfully on most bouts.	Consciously manages arousal successfully on 95%+ bouts.	Subconsciously/ consciously manages arousal control levels to optimize performance.
Shooting race plan		Informal plan: loops and bouts (P,S). Selects shooting lanes effectively.	Written plan, successful execution; post race analysis.	Able to adapt plan and respond to competition occurrences. Targets IPS.	Very adaptable to venue, type of competition and adapts quickly to occurring changes and accepts/ assesses risks at appropriate times. IPS can vary based on type of competition and conditions.

Shooting Skill Development: Analytical Skills

Skill	Bears	Learning to Train	Train to train	Train To compete	Train To Win
Shot analysis	Recognizes bad shot/ good shot (i.e. hit, miss).	Able to recognize errors in individual shots and call hit or miss.	Able to diagnose cause of errors and interpret corrective advice. Able to call error quadrant.	Able to diagnose and correct own errors with assistance or verification with coach. Able to call position of bullets.	Able to diagnose and correct own errors. Able to call accurate position of bullets.
Group analysis	Recognizes group centre of gravity.	Able to recognize and sometimes diagnose tendencies.	Able to diagnose cause of group errors and interpret corrective advice.	Able to diagnose and self-correct errors.	Able to diagnose and self-correct errors.
Competition analysis	Tendency is to focus on negative things but must be coached to positive interpretation of competition results.	Positive interpretation of competition results. Identifies areas of improvement from competition experience. Uses simple written race evaluation tools.	Positive interpretation of competition results. Identifies mental, physical, technical components for improvement. Uses more complex/detailed written race analysis tool.	Constructive critical review of performance. Able to generate detailed race analysis without the use of a tool to diagnose mental, physical, technical errors and successes in post race analysis with coach (re: IPS).	Constructive critical review of performance. Self-Diagnoses of mental, physical, technical errors and successes. Successfully manages IPS based on review.

Shooting Skill Development: Environmental Effects

Skill	Bears	Learning to Train	Train to train	Train To compete	Train To Win
Light	Aware light has an effect.	Uses "Lights up, sights up" rule under direction.	Uses "Lights up, sights up" rule effectively.	Understands subtle effects on aiming point.	Understands and manages subtle effects on aiming point and variations in sun position/cloud movement.
Wind	Aware wind has effect.	Able to identify winds and effects. Waits to shoot.	Makes reasonable sight adjustments at zero. Moves towards effectively managing wind in competition.	Manages wind effectively and dynamically in competition; corrections or aiming-off.	
Aiming-Off	Approximate 5-Star drill.	Effective 5-Star drill.	Able to control shots within 4 clicks.	Able to control shots within 2 clicks in consistent wind.	Able to control shots within 2 clicks.
Temperature	Effectively dresses for weather and mostly stays warm enough to shoot.	Effectively stays warm enough to shoot. Aware of effects on ammunition.	Takes weather in stride. Knows limits of ammunition used.	Able to compensates so that temperature has little or no effect on performance. Possesses extreme cold weather (-15 C) ammunition.	Automatically invokes IPS mental skills to off-set weather challenges. Has specific ammunitions tested for all weather conditions.

Long Term Psychological Development

The application of Sport Psychology to the Long Term Plan for Psychological Development presented below provides an outline of the key elements to be trained in children, followed by guidelines for young athletes taking a more regimented approach to sport. In the tables addressing the needs of athletes on a formal training plan, general guidelines are followed by specific recommendations for particular training years.

Guidelines for Early and Late Childhood

Age	Guidelines for the FUNdamentals Phase
Early and Mid Childhood (5-9 years)	• The critical element is to ensure that athletes have fun. • Unfulfilled motives will lead to drop out. Coaches should provide direction, but not expectations. They should make an effort to understand the multiple motives that have brought the participants to the sport. Until the coaches understand why the athlete is there, it is difficult to structure the environment such that the athlete's motives will be fulfilled. • It is vital that athletes are provided with opportunities to experience success by intrinsic and extrinsic measures. • Assessments of competence and success should be based primarily upon personal improvement (although athletes can also use normative comparison if they are actually doing better than other people).

Age	Guidelines for the Learn To Train Phase
Late Childhood and Pre PHV adolescents (9-13 years)	• The critical focus of this phase should be athlete motivation. This is where you want to instill a love of the sport. Normally you will only get one chance to keep athletes in the sport, so the first year is critical. • Self confidence is fragile in this phase. Be careful to set reasonable success criteria for any new skill learning tasks. • The vast majority of coaching efforts should be aimed at enhancing intrinsic motivation and enhancing perceived competence (by providing opportunities for success). • Motivation should be based upon the principles of Self-Determination Theory: namely, provide opportunities for autonomy in decision-making (i.e. an element of choice), relatedness (i.e. social/friendship opportunities), competence (i.e. must feel some sense of success, self or norm referenced) and relatedness (attributable to performance on task). • The focus must be on process-goals as opposed to outcome goals. Introduce the idea that goals should focus on things that they can control. Probably a single process goal for shooting and single process goal for skiing at one time is enough. Introduce the idea of post- race reflection (e.g. What did I enjoy today? What did I do well today? What will I try to do better the next time?). Introducing the idea of keeping a very basic "log book" may be a good idea (but becomes essential in the Train to Train phase). Post race reflection becomes the tool for introducing self-awareness. • Arousal control can be introduced with basic breathing techniques. (Note: teach both energizing and arousal control with breathing). • Basic introduction to visualization and self-talk can be implemented (keep it simple, global, and non-technical). • Coaches should work hard at creating a mastery-motivational climate (where praise and reward is contingent upon athlete effort, personal development, and personal mastery of the environment).

Guidelines for the PHV Transition Zone and Train to Train Phase

General Guidelines

- Judge the behaviour, not the person.
- Persistent practice towards mastery is essential if mental skills are to be of any value in stress situations, e.g. in competition.
- Self-Awareness. Encourage athletes to identify psychological, emotional, and environmental factors that hinder their development in both competition and training situations. Encourage athletes to identify psychological, emotional, and environmental factors that enhance their development in both race and training situations. Emphasis should be placed upon those factors that are within the athletes' control.
- Self-esteem and positive self-regard must be developed and nurtured: Ensure that self-worth and self-regard are continually built, and are not made conditional upon success/outcomes in biathlon.
- Goal setting should be formalized. Daily, weekly, monthly, and (possibly) seasonal goals should be written in training logs; evaluated and adjusted to circumstances on a regular basis. Goals should still primarily focus on process (as opposed to outcome) in order to set direction. They must be flexible, realistic and challenging.
- Athletes must be encouraged to assess their levels of commitment, discipline, and resilience towards achieving their goals (see paper by Holt & Dunn, 2004). Confidence building should be emphasized.
- Athletes need to be taught to identify, record, and reflect upon the reasons why they should/will be successful. (Note: The importance of the training log cannot be understated for this important exercise).
- The importance of taking personal responsibility and a willingness to be held accountable for personal behaviours and personal development should be encouraged. To aid with this, athletes should be introduced to the idea of regularly and accurately assessing their success and failure attributions (i.e. Why was I successful today? What factors contributed to my success today? Why did I fail today? What factors contributed to my failure today?).
- Competence and success should continue to be judged in relation to self-referenced, self-controlled process/mastery goals.
- Visualization, self-talk, and arousal control can all be taught in a more formal manner.
- Organizational skills and time management skills should be taught and emphasized.
- Maintaining a healthy balance with school, biathlon, friends, and family should still be encouraged by coaches.
- Pre-race routines can be introduced in the 3rd and 4th years of this phase.

Guidelines for the PHV Transition Zone and Train to Train Phase (con't)

Age/Training age	Yearly Guidelines
13/1 year	Self-awareness in order to increase self-esteem and self-image. Visualization and arousal control become key mental skills. First competitions will serve as basis for the following year's components. Introduce accountability and responsibility. Begin integrating mental training with physical activities and real circumstances.
14/2 years	Self-awareness exercises are now based on racing performance and training behaviour from past season. Introduce goal setting (short term – 1 yr.). Process goal setting should occur routinely for key events and training objectives. Use of visualization and arousal control for preparing for competitions. Emphasize accountability and responsibility (now through organizational skills and time management particularly).
15/3 years	Same as year 2 with introduction of positive self talk (PST) and attentional control. Goal setting now encompasses long-term goals. Further integration of mental skills into technical training and competition.
16/4 years	All major mental skills have now been introduced, leading to self-actualization. Competition plans are now used based on self-awareness and other mental skills.

Guidelines for Train to Compete Phase

General Guidelines

- Practice and perfect combined mental and physical skills through persistent practice.
- Finely-tuned pre-competition plans, competition plans, and pre-shot routines should play an increasingly greater role in preparation and performance.
- At the onset of the T2C phase, athletes should be sufficiently self-aware to know how they want to feel, and start to understand what they must do to reach their Ideal Performance State (IPS). A good awareness of pre-race and within-race IPS should be established.
- Goal setting should now encompass a recognition of the sacrifices that must be made in other areas of one's life in order to accomplish in Biathlon. Long-term goals now extend into seasonal goals and beyond.
- Athletes should be able to incorporate and understand a variety of coping mechanisms in order to deal with both competitive pressures and non-competitive pressures. For example, athletes should be educated about, and able to employ, a variety of problem-focused coping, emotion-focused coping, and avoidance coping strategies.
- Athletes should recognize (or be taught) about the importance of accessing and employing social support (be it emotional, informational, or tangible) from friends, family, coaches, and teammates to help deal with the increasing pressures and demands of the competitive environment. Confidence building should continue, and should come from within.
- Athletes should recognize that improvements now come in much smaller increments during the later stages of this phase, so even the smallest accomplishments must be recognized and celebrated.
- Athletes should a have a wealth of confidence-building sources readily available, and must believe in them. Patience must be linked with goal setting because goals become harder and harder to achieve.
- Teach athletes to understand the difference between optimistic attributional styles (e.g. attribute failure to unstable-controllable factors) and pessimistic attributional style (e.g. attribute failure to stable-uncontrollable factors).
- Critically asses success and failure attributions to provide rigourous self-evaluation.
- Self-talk scripts should be brief, well-learned, and powerful. Thought stopping, thought substitution, and cognitive restructuring should all be learned and implemented. For example, "perspective taking" is one technique that can be readily employed.).
- Visualization routines should be become detailed, controlled, and incorporate all of the necessary senses (see, feel, hear, emotions, etc.) that will be in operation during performance.
- Arousal control techniques should be practiced and implemented in a variety of settings under a variety of conditions.
- Implementation of team building into this phase given that the athletes are probably training together either with clubs, provincial teams, or junior national teams.
- Acknowledge importance of external stressors (family, work, money, school) and address through social support network (24hr athlete).

Age/Training age	Yearly Guidelines
17/5 years	Athletes to be cognisant of mental skills required for biathlon through education and experience. Self-awareness is critical (use increasing consistency in competition results to provide a clearer picture of positive and negative influences on performance). Race plans are now an important factor in performance. Introduce Zones of Optimal Performance (ZOP) and experimentation in this area. Goal setting includes short term, long term and dream goals. Introduction of pain tolerance with systematic loading of anaerobic lactic system. Simulation exercises now are very effective tools to train athletes for coping strategies.
18/6 years	Establish individual Ideal Performance State (IPS) according to ZOP analysis in privious year of racing (all based on self-awareness). Race plans are now a critical factor in performance. Mission statements and codes of conduct become important as travel becomes more frequent and athletes participate in training centre activity. Acknowledge and appreciate the of needs of others and the contribution of teammates to mutual success.
19/7 years	Re-assess IPS and try to optimize all ZOP's according to another year of race and training experience (self-awareness). Race plans are now tactically and technically detailed.
20/8 years	Same as year 7. Begin transformation of IPS information into "Performance On Demand" by selection of appropriate tools/skills.

Guidelines for Train to Win Phase

General Guidelines

- Athletes should re-acquaint themselves with their "reason why" and should have a complete understanding of their strengths and weaknesses, and should have well-learned mental strategies in place for dealing with each and every situation that they might encounter. Expect the unexpected: always have a plan B.
- Insure that self confidence becomes a habit in this stage.
- The integration of all mental skills should be accomplished, such that combinations of visualization, self-talk, goals, and arousal control can be implemented simultaneously to achieve the desired effect.
- A complete awareness of what can and what cannot be controlled should be in place.
- A clearly defined "athlete philosophy" should be in place that guides behaviour and conduct (this should also include a statement of those things that the athlete values).
- Whenever possible, training behaviours should reflect competition behaviours. Athletes should "test" their psychological skills by creating "simulation" events in their training schedules to determine how well they are able to employ their mental skills strategies.
- Athletes should understand that there is no "magic pill" that will suddenly "work" in the pressure of major competition, and that there is no "quick fix" solution from a psychological perspective. As such, the practice of psychological skills should be a committed goal of athletes in this phase.
- Personal motivation should become the sole responsibility of the athlete.
- Athletes should understand that their ideal performance state is rarely experienced under conditions of high pressure (e.g. World Championships or Olympic Games). As such, learning to function while out of their "individual zones of optimal functioning" becomes as important as learning to find the IZOF in the first place. The athlete needs to trust the coping skill that he/she has developed to perform in these situations.
- The principles of self-determination theory are once again important. Coaches have to consider the importance of autonomy (i.e. choice), relatedness, and competence on the athletes' intrinsic motivation at this phase of the LTAD-M and consider giving the athlete some say in his/her training program, No amount of extrinsic motives will ever be as powerful as a strong sense of intrinsic motivation.
- As athletes now live, train and travel with other athletes.

Age/Training age	Yearly Guidelines
21/9 years	Re-assess IPS. Goal is Performance On Demand (POD) regardless of circumstances. Based on years 6-8, utilize mental skills to recognize optimal performance parameters. Consolidate physical, technical, mental skills in toolbox so as to produce Performance On Demand in competitions and practices.
22/10 years	Same as year 9 plus planning a mental skills model for Olympic Winter Games (OWG) using World Championships as a trial.
23/11 years	Same as year 10. Optimize POD under a variety of practice and competition circumstances.
24 /12 years	Implement POD at OWG, BWC and similar events.

The following tables describe the resources required to deliver programs that conform to the Biathlon Canada LTAD Program model. Resources are organised in two tables, one for clubs and one for training centres. In both tables, the resources are organised and detailed to show the developmental progression.

Club Program Development Model

Programs for developing and recreational athletes, living at home, attending high school, tertiary education full time and/or working full time or part time, not attending a Divisional or National Training Centre: Parts 1 and 2.

Club Equipment and Services, Part 1

PHASE	Descriptor	*Athlete: Coach ratio	Consultant support level 1	Equipment	Other equipment	Medical Support	Emphasis
Mid Childhood	Under 11	10:1 plus parent helpers	NA	Snow skis Access to Rifle	Competitive XC ski clothes and summer training clothes	Annual checkup - GP	FUN introduction to biathlon components
Late Childhood (Learn to Train)	Beginners and pre-PHV adolescents	10:1 plus parent helpers	NA	Snow skis Access to Roller skis Rifle HR Monitor	Competitive XC ski clothes and summer training clothes	Annual checkup - GP	Biathlon skills acquisition. Sport particip-ation skills
Train To Train	Club-based Adolescents, post PHV; high school	2-4:1	NA	Rifle Roller skis Snow skis HR Monitor	Competitive XC ski clothes and summer training clothes Access to Noptel	Annual checkup - GP	Formal training. Transfer skills from practice to performance.
Recreational Adults	Young adults or older who are recreational biathletes	2-5:1	Personal trainer	Rifle Roller skis Snow skis HR Monitor	Competitive XC ski clothes and summer training clothes	Annual checkup - GP. Fitness assessment for over 40's.	Training and competition as recreation

* Ratio of athletes to volunteer coaches during practices.

Club Equipment and Services, Part 2

PHASE	Descriptor	Training venue	Competitive Opportunities	Training Camp Support	Testing requirements	Education	Supervised training regime	Other sport or exercise
Mid Childhood	Under 11	Club Competitions	2-3 Regional, provincial level	NA	Biathlon Bears Achievement criteria	Public school	1-2 sessions weekly 100% shooting	2-4 sessions per week plus school PE
Late Childhood (Learn to Train)	Beginners and pre-PHV adolescents	Club and Regional Camps Competitions	2-6 Regional, provincial level	Coaching	Biathlon Bears Achievement criteria	Public school	2-3 sessions weekly 100% shooting	2-4 sessions per week plus school PE
Train To Train	Club-based Adolescents, post PHV; high school	Club and Div. Camps Competitions	12-15 National, provincial level	Coaching	Field tests	Highs school	3-5 sessions weekly 100% shooting	2-5 sessions per week plus school PE
Recreational Adults	Young adults or older who are recreational biathletes	Club Regional and provincial competitions	2-6 Regional, provincial level	Coaching	NA	College, university or work.	1-2 sessions weekly 100% shooting	2-4 sessions per week

Training Centre Development Model

The following tables establish the key and ancillary support mechanisms that should be in place once an athlete has been selected to a national team training squad or is committed to the LTAD process and in pursuit of a position with a national team with the goal of attaining international podium performances.

Training Centre Equipment and Services, Part 1

PHASE	Descriptor	*Athlete: Coach ratio	Consultant support level 1	Consultant support level 2	Basic equipment	Other equipment	Massage physiotherapist	Medical support
Train to Train	Talent ID and Youth	8-10:1	TEAM SERVICES Nutrition		Rifle Roller skis Snow skis	Competitive XC ski clothes and summer training clothes		Compile medical history
Train to Compete	Youth Dev.	6:1	TEAM SERVICES Nutrition		Rifle Roller skis Snow skis HR Monitor Noptel	Competitive XC ski clothes and summer training clothes	Seasonal musculo-skeletal assessment	Yearly assessment prior to training
	Junior Dev.	4-6:1	TEAM SERVICES Strength Psychology Physiology Nutrition		4 CS Spare BP HQ Ammo Rifle Roller skis HR Monitor Noptel	Competitive XC ski clothes and summer training clothes HQ cycling eqpt Supplements	0.5 hour massage weekly Regular musculo-skeletal assessment	Team Doctor Support with routine visits (2-4 annually)
Train to Win	Senior Dev.	4-6:1	TEAM SERVICES Strength Psychology Physiology	Nutrition 1:1 Tour coaching support services	5 CS Classic Eqpt Spare BP HQ Ammo Rifle Roller skis HR Monitor Noptel	Competitive XC ski clothes and summer training clothes HQ cycling eqpt Supplements	1 hour massage weekly and physio as needed	Team Doctor Support with routine visits (2-4 annually)
	Olympic Dev.	4-6:2	INDIVIDUAL Strength Psychology Physiology	Skiing coach Shooting coach Equipment Technician	6 CS Classic eqpt Spare BP HQ Ammo Rifle Roller skis HR Monitor Noptel	Competitive XC ski clothes and summer training clothes HQ cycling eqpt Supplements	Both as needed	Travelling Medical support on Tour

* Ratio of athletes to full time coaches in the program. Legend: **BP** - Boots and Poles; **CS** - Competitive Skis [pairs of]; **HQ** - High Quality; **HR** - Heart Rate monitor

Training Centre Equipment and Services, Part 2

PHASE	Descriptor	Training venue	Competitive opportunities	Personal income	Training camp support	Testing requirements	Education	Supervised training regime
Train to Train	Talent ID and Youth	100% training center-based	Provincial towards national as competency dictates	n/a	Coaching services	Field tests	High school	2-3 sessions weekly 100% shooting
Train to Compete	Youth Dev.	Intro camp based activities 2 x yearly Early snow exposure	National and NAC level; preparation for WYCH. 6-10 international competitions 12-15 National, provincial	DEV Cards and provincial AAP to cover programming needs $8-10K annually	Ammunition Room and Board	Blood work Field tests Lab VO2 if supported by CSC	Sport High School and college programs	4-8 sessions weekly 100% camps 100% shooting 300 days
	Junior Dev.	Camp based activities 3-4 x yearly Early Snow Camp Intro Glacier Camps	WJCH and EC Tour exposure 1-2x annually based on maximizing scheduling 8-15 international competitions	National AAP and access to continued education $15-20K and access to continued education	Facilitate and support transport Ammunition Room and Board	Routine Blood work Field tests Lab VO2, 1-2 annually	Part time post secondary schooling with a sport collegel	6-10 sessions weekly 100% camps 100% shooting 300 days
Train to Win	Senior Dev.	Camps as needed Early Snow Camp Glacier Training	EC and ECH exposure with extended selection processes for BWC (8-15 international competitions)	National AAP and access to continued education $15-20K and access to continued education	100% support	Routine Blood work Field tests Lab VO2 1-2 annually Anthropometrics as needed	Part-time University training	8-12 sessions weekly 100% camps 100% shooting 320 days
	Olympic Dev.	Schedule based on optimal environment for maximized specificity Routine altitude exposure, early snow and glacier camps	All BWC and WCH events with use of EC tour to prepare for competitive season (20-24 International competitions)	$20K net income and access to Athlete Career Path	100% support	Routine Blood work Field tests Lab VO2 1-2 annually Anthropometrics as needed	Finalize schooling requirements and access Athlete Career Pathway	8-12 sessions weekly 100% camps 100% shooting 320 days

Introduction

This section presents the tests in four distinct parts in order to clearly reflect the differing objectives of the tests. The general guidelines are followed by tests designed for the pre-participation evaluation of the athlete. The second part addresses testing for pre-PHV(Peak Height Velocity) and immediately post-PHV athletes (athletes passing through PHV). These tests may also be used to establish relatively homogeneous training groups.

The third section describes tests that are designed for collecting comparative data, both for between year and between generation comparisons. The test results should be saved in a database and correlated to biathlon specific performance outcomes.

The fourth section consists of tests designed for the monitoring of ongoing training. Some of these tests should be used daily to monitor the general health of the athlete and the readiness of the athlete to accept further training. Other tests may be applied at the end of any significant training block where the performance attribute measured by the test has been trained.

Monitoring and Testing Guidelines

- Athletes must be healthy at the time of testing.
- Testing protocols and testing environments must be standardized if test results are to be comparable across times or across generations.
- Test at consistent times in the training year to make year-to-year comparisons possible.
- It is important for testing to occur at reasonable times in the training schedule.
- Tests should be performed after there has been a period of recovery from the training load that is to be evaluated.
- Recovery time and recovery activities must be consistent for tests that will be compared over time.
- Pre-season assessment testing should be done between May 15 and June 15.
- Test in the fall between September 15 and October 15 to evaluate the effectiveness of summer training.
- Tests administered on the same day, or on successive days, must be done in the same order each time so that residual fatigue and recovery between tests is the same each time the series of tests is administered.
- Allow recovery time after testing and before training is resumed.
- Testing is stressful and resource intensive. Use only those tests that evaluate performance parameters that are associated with critical milestones, e.g. PHV; measure recently trained performance components and/or which you can repeat frequently enough to establish meaningful trends.

Pre – Participation Screening

Each year, before training is started athletes should be screened for their basic health status through the use of medical tests performed by a doctor and physiotherapist. There are two main goals of this screening.

- Identify any underlying medical condition that would put an athlete at risk of injury or illness.
- Develop and implement a plan of care for identified issues.

Following is a list of screening tests that should be considered and can be discussed with the athlete's doctor and/or physiotherapist.

Head to toe:

- Visual screen and eye exam
- Abdominal organ exam
- Heart Exam, including fast heart rate, svt , and long QT
- EKG (if positive history)
- Echocardiogram (if murmur detected)
- Breast exam and education
- Testicle exam and education
- Lung exam (asthma) including: CXR ; Pulmonary Function
- Skin exam
- Supplement use
- Injury pattern (homocysteine)
- Neurochemical change with exercise
- Sudden death – especially septal hypertrophy
- Psychiatric disease

Blood tests:

- Hemaglobin(Hgb), Hematocrit(Hct), Reticulocyte count
- Dilutional anaemia – feosol: ongoing monitoring if levels high or low.
- Blood viscosity
- Ferritin
- Cholesterol levels
- Possibly endocrine tests such as testosterone and others.

Physiotherapist:

- Biomechanical survey
- Muscle/bone exam
- Muscle weaknesses
- Muscle balance
- Joint exam, especially ankles and shoulders
- Flexibility

Establishing Development Level and Cohesive Training Groups

The Biathlon Canada LTAD Model is based on the concept that there are windows of opportunity during growth and development where the human body will be preferentially receptive to particular kinds of training (see Volume 1). These opportunities are mapped to the growth and development chronology via the Peak Height Velocity. Tools for measuring rate of height gain (velocity) are presented in this section.

Effective training opportunities are created through the type of environment established by and for individuals in a group. Athletes should be selected into groups with closely similar abilities with respect to the training process offered. The following tests offer an objective way to establish the growth and development stage and PHV-based training age of prospective athletes. It should be noted that training groups may be different for different kinds of training. For example, within the same chronological peer group, various overlapping sub-groups could result for video analysis of technique vs. weight training vs. recovery vs. anaerobic intervals.

The following is a series of eight tests, usually done in the order listed, that can be used to establish physiological groupings:

Peak Height Velocity

PHV has several components that should be measured at least monthly, and more frequently close to, and immediately after, the peak. Standing height, sitting height and arm span provide an insight into the differential, often uncoordinated growth rates that pubertal athletes experience.

Standing Height

This is a combined measure of trunk and leg growth rate.

Equipment Required: Metric measuring tape, 90-degree carpenter's square.

Procedure: Athlete stands in bare feet or socks, with heels, buttocks and shoulders pressed against wall, heels together, arms at side, palms facing thighs. Athlete looks straight ahead, takes a deep breath and stands as tall as possible, without tilting head back or lifting heels from the floor. Coach places the 90-degree carpenter's square against wall with the base resting on the top of the athlete's head and marks the lower edge of the square on the wall (Use painters tape to protect the wall). Measure the standing height to the nearest millimetre (0.1cm). To compute the height velocity, subtract the previous height from this measurement and divide by the number of days elapsed since the last measurement. Plot on a graph of velocity vs. time. For clinical accuracy, the measurement should always be made at the same time of day and the recorded height should be the average of three measurements.

Sitting Height

Measures trunk growth. Can be subtracted from the previous measurement to measure leg growth.

Equipment Required: Metric measuring tape, 90-degree carpenter's square and a box or stool with a hard seat. Use the same seat each time.

Procedure: Athlete sits on the bench with knees forward and bent, hands resting on thighs. Thighs should be parallel with the floor, buttocks and shoulders pressed against the wall with the tape positioned midline behind the athlete. Athlete looks straight ahead, takes a deep breath and sits as tall as possible, without tilting head back. Coach places the 90-degree carpenter's square against wall with the base resting on the top of the athlete's head and marks the lower edge of the square on the wall. Measure the sitting height to the nearest millimetre (0.1cm). Measure the seat height to the nearest mm too. To compute the trunk height, subtract the seat height from the sitting height measurement. To compute the trunk length velocity, subtract the previous trunk-height from this measurement and divide by the number of days elapsed since the last measurement. Plot on a graph of velocity vs. time. For clinical accuracy, the measurement should always be made at the same time of day and the recorded height should be the average of three measurements.

Arm Span

Measures rate of arm and shoulder growth.

Equipment Required: Metric tape measure at least 3m long. Mount tape horizontally on a wall, approximately 1.5m from the ground. Use a corner as the zero point as an aid to establishing tape alignment.

Procedure: Athlete stands upright with back against wall, feet together, heels, buttocks and shoulders against the wall, as for Standing Height, above. Athlete extends arms laterally at shoulder height, palms facing forward, with the middle fingers and arms parallel to the tape measure. Measure the distance from the tip of the middle finger on one hand to the tip of the middle finger on the other. Record the arm span to the nearest millimetre (0.1cm). To compute the arm length velocity, subtract the previous arm length from this measurement and divide by the number of days elapsed since the last measurement. Plot on a graph of velocity vs. time. For clinical accuracy, the measurement should always be made at the same time of day and the recorded width should be the average of three measurements.

The chronological age at PHV may be estimated retrospectively from these measurements using a statistical model developed at the University of Saskatchewan (see Appendix 1: Peak Height Velocity Calculator).

Explosive Power Tests

The next series of tests measure physical performance characteristics that can be used to group athletes with similar performance characteristics for physical training. Athletes with similar performance characteristics will form cohesive and effective training groups. Athletes who are post-PHV and who are entering the second strength and speed windows normally do well in these explosive power tests, particularly if the recommended sequencing of pre-PHV training from this model was applied earlier.

3KG Shot Throw

Measures explosive arm strength.

Equipment Required: 3kg medicine ball, Metric tape measure, duct tape.

Procedure: Athlete sits with their buttocks, shoulders, back and head against the wall. Legs should be straight out, toes up, resting on the floor directly in front of them (not in a V-shape). Using a chest pass motion, the athlete throws the ball as far as possible forwards. Coach marks the first impact point with duct tape. A one armed throw does not count. If the shoulders lose contact with the wall, this does not count and throw must be redone. Allow one rehearsal and three valid throws per athlete.

Scoring: Measure all three throws from the wall to where the ball first comes in contact with the ground. Record the average and maximum distance.

30 or 60 Second Box Jump

Measures plyometric speed and power from a two-footed vertical jump.

Equipment Required: Sturdy box 40cm high, about 30 x 50 cm square on top; stop watch; one person for timing and one person for counting jumps.

Procedure: Place box in a flat non-slip area; box must be stable and secure. Athlete begins the test standing on top of the box. On "Go", they jump down on one side of the box, and immediately jump back up two-footed, and then jump down on the opposite side, continue to alternate sides for the remainder of the testing time. Athletes who are younger than PHV-3 jump for 30 seconds. PhV-3 and older athletes jump for 60 seconds.

Scoring: Record the number of times the athlete contacts the top of the box. Record total at both 30 sec. and 60 sec. interval.

60 Meter Sprint

Measures acceleration speed and anaerobic leg power.

Equipment Required: Stop watch that records multiple splits; measuring tape. Straight, dry, flat running surface or athletic track.

Procedure: Mark a 60 meter distance with visual reference (flags, cones) at the start and at the end. Athletes begin from a standing start position (at zero m). Coach stands at the finish line (60m). With one arm raised, use: "ready, set, GO!" simultaneously dropping the arm on "GO". Stop the watch (press lap) when the athlete's chest crosses the line. Allow 3 trials for each athlete, with the same pause between trials for each athlete.

Scoring: Record the time for all 3 trials to the nearest 0.1 seconds; compute and record the average.

20 Meter Shuttle Run (Leger)

Equipment Required: A full description of the set up for and the conduct of this test is given with the purchase of the Leger tape or CD. The Leger Kit can be purchased from:

Fitness Appraisal Certification and Accreditation Program
FACA-Quebec
Universitè de Montrèal
Dèpartement d'Èducation Physique
CP 6128, Succursale Centre-Ville
Montrèal, QC Canada H3C 3J7
Tel. 514-343-2471, Fax 514-343-2181
Email fauchart@ere.umontreal.ca

Procedure: Follow the directions given for this test exactly.

Scoring: Record the last level of shuttle the athlete successfully completed and use the tables provided to predict maximum oxygen uptake. The Leger package also includes other tests that can be used to diagnose athletic ability and track progress, as well as normative tables from the general population. Once all these tests have been completed you can evaluate your athletes to determine how the training (sub) groups should be structured. Performing the growth tests every two to three months and the fitness tests two times during the training season, May - June and Sep. - Oct., should be adequate for sorting pubertal athletes.

Shooting Position Test

Dominant Hand and Eye

Normally stable; occasionally changes during puberty. The dominant eye is the best eye to use for shooting. It nearly always coincides with left or right handedness.

Equipment Required: 6" x 6" index card with a small hole in the middle(big enough for a finger to fit in), Duct tape, traffic cone or similar object to sight on.

Procedure: Use the duct tape to mark where the athlete should stand. Place the traffic cone six meters (20 feet) away from the duct tape. Ask the athlete which hand they write with – this is their dominant hand. Ask the athlete to hold the card at arms length with this hand and, with both eyes open, align the card so that the traffic cone can be seen through the hole. Coach stands in a position where he/she can see both the athlete's eyes and then gives the following instruction: "Please close your right eye". Verify that the right eye is closed and ask "Can you still see the cone?"
If the cone disappears from view when the right eye closes, the athlete is right eye dominant. If the cone remains in view they are left eye dominant. Record which hand they write with (dominant hand) and their dominant eye. Shooting position, shooting instruction and handedness of rifle should be based on these values.

Tests For Comparative, Sport Specific Data

If you are training a group of athletes, it is natural to want to check the progress of their training against that of other, similar groups around the country or in the past. This section will outline the tests that Biathlon Canada uses to maintain a database of training results from around the country. It is possible to use these test results to see if your athletes are on the "performance curve" necessary to succeed at the national and international level. These tests may be performed at any Biathlon training site.

Shooting Tests

Precision Shooting Test

Equipment: Standard Shooting Federation 6-bull paper targets for 50m, with ten prone and ten standing scoring rings.

Procedure: Athletes will shoot 10 scoring shots on each bull: half prone, half standing. Athletes will single-load each round within the time limits of the test. Athletes may pause between shots at their discretion. Athletes will zero themselves but can receive advice from the coach. There is no limit on the number of shots used to zero. Checking of zero at anytime during the test is allowed, but there is no time-out allowance for zeroing or checks.

40-shot test (up to PHV-3) 60min. Zeroing and test included.
60-shot test (PHV-3 and up) 75min. Zeroing and test included.

Scoring: Simple sum of shot points, total out of 400 or 600. Every ring counts and every shot counts. Shots that cut a line count up. If a target has more than ten (10) bullet holes, the highest scoring bullet is discarded.

First Bullet Test

Equipment: Standard Shooting Federation 6-bull paper targets for 50m, with ten prone and ten standing scoring rings. Four magazines, loaded with one bullet each, for each test.

Procedure: Athletes may self-zero or be assisted by the coach. Athlete stands 1.5 meters behind the shooting mat with rifle on back, magazine out, one bullet loaded in each clip, stored in clip holder. Snow covers closed, poles in hand. On "GO" athlete enters shooting position and fires one shot. After firing, athlete returns to start position as fast as possible. During the performance, the coach records the elapsed time at which the athlete returns to the start line (for each shot).

Non-carrying athletes: Same procedure as above except the rifle is placed on the mat with the clips lying on the mat or in the clip holder according to local practice. Athlete will perform the safety check and unloading of magazine as part of their exit procedure. Single bullets can also be left on the mat in the case of no magazines for the rifle.

Scoring: After each shot the score and the time is recorded for each athlete. At the end of the test (4 shots prone / 4 shots standing or 8 shots prone) the total score is recorded and the total elapsed time is computed. Calculate the points, time/score ratio for each shot. Example: 25 seconds/ 8 points = 3.1). Record the average of the point score for each position.

Biathlon Shooting Test

Equipment: Biathlon Canada five-across paper targets or metal plate targets. Four magazines, each with 5 bullets loaded.

Procedure: Athletes may self-zero or be assisted by the coach. Athlete stands 1.5 meters behind the shooting mat with rifle on back, 4 clips loaded, stored in clip holder, snow covers closed, poles in hand. On "GO" athlete enters shooting position and fires five across. After firing, athlete returns to start position as fast as possible. During the performance, the coach records the elapsed time at which the athlete returns to the start line.
Repeat for a second set of 4 magazines. In total, 20 prone and 20 standing.

Non-carrying athletes: Same procedure as above except the rifle is placed on the mat with the clips lying on the mat or in the clip

holder according to local practice. Athletes will perform the safety check and unloading of magazines as part of their exit procedure. Single bullets can also be left on the mat in the case of single shot rifles.

Scoring: After each shoot, the hits and misses, and the time per each 5-shot bout is recorded for each athlete. At the end of the test (20 shots prone / 20 shots standing) the total score and the total elapsed time is recorded. Calculate the score/time ratio for each bout and multiply by 100. Example: 4 hits in 27 seconds = 14.8. Five hits in 27 seconds = 18.5. Four hits in 19 seconds = 21.0. Coaches should establish expected target times for 5 hit bouts and continually remind athletes of the strategic consequences of improving speed at the cost of accuracy.

Physiological Tests

Strength Endurance Test

Schedule 40-45 min. for this test. Once started this test does not stop until the end of the last minute of Box Jumps. It is very demanding.

Equipment: Sit up mat; Chin up bar; Dip bars or bench, 40cm high box (from box jump test above).

Procedure: Start the test with a 15 min. warm up run. Athletes do each of the exercises twice, 1min on, 1min. rest, 1min. on, 1min. rest and then on to the next exercise with no additional break other than the 1min.

Sit ups,
Pushups,
Chin ups,
Dips,
Box Jumps

Scoring: The number of repetitions is counted for each 1min. of work for each exercise. Keep the method, order and rest periods the same each time the tests are run.

Exercise descriptions: Sit Up – Legs bent to approximately 90° and feet held. Shoulder blades must contact the floor each time. **Tricep Push Up** – Elbows close to body, upper arm must be parallel to the floor at the lowest point and fully extended at the end of the upwards push. **Chin Ups** – Grip is shoulder width apart, palms facing away, knees bent and feet together. Chin must touch top of bar to count. **Dips** – Full-body dips performed on parallel bars. Upper arms (humerous) parallel to bars at bottom of dip, arms fully extended at top. If a bench is used as an alternative, trunk must be kept vertical to minimize assistance from abdominal muscles. **Box Jumps** – Start on the ground, with the box in front of the athlete. Simple two-footed, jump onto a 40cm box, and back down again. At least 2/3 of the foot must contact the platform of the box for a jump to count.

Allow time for a 10-15 min. cool-down, recovery exercise at the end.

Endurance Run Test: 3000m Time Trial

Equipment: Standard 400m running track or a flat road loop of known distance; stop watch; cones to mark finish. An asphalt track is ideal, but a cinder track will work.

Procedure: Allow athletes 15 min. to warm up. Athletes use a standing start. Time the 3000m from "Go". Requires 7.5 laps on a 400m track.

Scoring: Each lap should be split timed and a total time taken for the 3000m. Heart rate/lactate data can be collected if monitors are available.

Monitoring Training

The following tests are used to monitor training progress and to predict training readiness. It is important to have objective measures of training readiness to go along with the reported feelings of athletes. Many of these tests are best done with the help of a heart rate monitor that can download its measurements to a computer. Some of the tests require more equipment than others, however, there are several tests described below that give coaches clear information without large equipment investment. Not all of these tests are required in a good monitoring program. It is up to the coach to determine which ones best suit their coaching situation (See Guidelines, above).

Base Line Monitoring

Training Diary

All athletes embarked on a formal training program must keep a training diary. This will record the training done, the circumstances of the training, personal notes about how the process felt, mental state, and any other individualised factors that the coach recommends that the athlete pay attention to.

Sleep and Sleep Quality

As part of a complete training diary, athletes should be asked to track their hours of sleep daily and record a simple rating for the quality of their sleep (1-10). Sleep quality is a good indicator of training readiness. Disturbed sleep patterns are a good prognostication for poor training results.

Orthostatic (RUSKO 90 sec. test) Heart Rate Test

This is the simplest cardiac-based autonomic function test that can be performed by athletes at home or in field conditions. This test must be done at the same time of day each day to get reliable repeat tests; preferably just after waking up in the morning.

Equipment: Polar heart rate monitor or equivalent, preferably with downloading features and beat-by-beat recording capability. The testing procedure is identical for both of the Scoring versions given below.

Procedure: As described in the following table. Schedule ten minutes for this test:

Time (min)	Actions	Record
0.00	Athlete puts on HR monitor and lies down (supine), breathe, relax, and remain inactive.	Record zero time.
6:30	Start recording for average heart rate.	Record average HR for last 30 sec. up until 7:00 min. (Supine-HR)
7:00	Stand up immediately after recording average HR. Continue recording. Remain relaxed and inactive.	
7:00	Continue recording. Continue standing. Remain relaxed and inactive.	Record the peak HR value in the first 30 sec. in standing position. (Standing-HR)
08:00	Prepare to record the average HR for next 30 sec.	
08:30	Test ends.	Record average HR for last 30 sec. in standing position. (90Sec-HR)

There are two ways to use this data to monitor changes in stress level:

Non-beat-by-beat HR Monitors: Establish a reference baseline for each of the three values: Supine-HR, Standing-HR and 90Sec-HR. The test should be done on 4-6 consecutive days at a time of the year when the athlete is known to be healthy, in a good state of mind and not in a heavy training phase. Late April-early May would be optimal.

Plot a graph of the HR values vs. Days. The test is then repeated at the same time, on the same day each week during the training program. The three weekly values are recorded on graph paper or graphed in Excel, to extend the three parallel lines of HR vs. Day. Increase the testing frequency during high load micro cycles, when travelling or changing venues.

Scoring: Sympathetic nervous system activation, caused by stress, increases the Supine-HR and the 90Sec-HR. It also slightly increases the Standing-HR (peak) value. A rising Supine-HR and a rising 90Sec-HR are symptomatic of increasing stress or fatigue, confirmed by an increase in Standing-HR. Fatigue and stress could be caused by training load, illness, family matters, change in venue (e.g. glacier trip). A sudden shift upwards in the 90Sec-HR often precedes a cold and is a warning sign. Converging points with an upward slope in the graph indicate that the coach should pay particular attention to the athlete's circumstances and training activity.

The parasympathetic nervous system counters the sympathetic nervous system. Supine-HR and 90Sec-HR both decrease when the parasympathetic system is active and in good shape and the Standing-HR peak rises. Downward trending lines are a sign of decreasing fatigue and stress.

Beat-by-Beat HR Monitors: The Polar beat-by-beat (BYB) recording HR monitors can also download the recorded data to computer software provided by Polar. The ten minutes of HR data recorded in the test is displayed in a graph which allows comparison of successive HR tests on a beat-by-beat basis.

Establish a reference set to establish a baseline. The test should be done on 4-6 consecutive days at a time of the year when the athlete is known to be healthy, in a good state of mind and not in a heavy training phase. Late April-early May would be optimal.

Scoring: The average values from these recordings can be interpreted in the same way as those for non-BYB HR monitors (above). Trends are very clear in plots of successive test graphs provided by the Polar software. The BYB HR monitors display the variability in heart rate from beat-to-beat during the testing zones: supine, standing peak and standing for 90 sec.

Rusko indicates that increased variability from beat-to-beat is an additional sign of increased parasympathetic activation. Increased stress decreases variability. This can also be used to monitor training readyness. The Polar software includes a calculation of an Over Training Index, based on the principles outlined above, together with a graduated alert system. This may be used in place of the graphing of average values.

Reference: More detailed information and research background can be obtained from the original publication, H. Rusko, Editor, Handbook of Sports Medicine and Science: Cross Country Skiing, Blackwell Publishing, 2003, p. 142 – 145.

Maximum Aerobic Power (MAP) Test (Leger)

Evaluation of fitness improvement after a period of training. This is the Leger shuttle test described above in section two. It measures Maximum Aerobic Power (MAP) and also predicts VO2 Max.

It is commonly performed 2-3 times between June and November when the training focus is on improving aerobic performance abilities.

Scoring: Record the MAP values and estimated VO2Max.

Conconi Test

Used to establish anaerobic threshold. The anaerobic threshold can be used to establish training zones and to evaluate fitness improvement after a period of training.

Equipment: 400m track; stop watch, HR (Heart Rate) monitor (recording monitor highly desirable).

Optional equipment: Lactate analyzer; bicycle with speedometer.

Procedure: Coach pre-establishes 6 incremental heart rate targets:

For athletes up to 15 years old the following generally work well:
140, 150, 160, 170, 180, Max
For older athletes (15 – 30) the following generally work well:
120, 150, 160, 170, 180, Max.
Athletes start with a 15 minute, low level warm up not exceeding normal Zone 1 pace (≤ 70% Max HR). Athletes then run at a constant pace that generates the target heart rate(s).
Each heart rate is maintained for 800m, except that the "max" loop may be shortened to 400m as necessary. Each 400m loop is timed. Average heart rate for each 800 m stage is recorded. Optional: Lactate sample taken quickly at the end of each 800m stage. Speed of each loop is calculated from times (or use bicycle pacer)

Scoring: Plot a graph of Heart Rate (y axis) vs. Speed(x axis) and/or a graph of Heart Rate vs. Lactate.

Heart Rate vs. Speed: Find the anaerobic threshold by determining where the increase in heart rate becomes non-linear in relation to the increase in speed i.e. where the slope changes. Anaerobic threshold typically occurs around 80 – 95 % of maximum heart rate, depending on the training state of the athlete.

Heart Rate vs. Lactate: Find the anaerobic threshold in either of two ways using lactate. Method one, find the point where lactate begins to accumulate in a nonlinear fashion as it relates to Heart Rate, i.e. the upward inflection point. Alternatively, the lactic acid threshold is often defined as the HR (point) where the lactate curve crosses 4mmol/l concentration.

Improved fitness is indicated when the curve generated moves down and to the right relative to earlier tests.

Training Zones: Training zones can be assigned using the threshold determination as the starting point. Following are examples for speed and lactate methods:

Heart Rate vs. Speed: Threshold: 180bpm (middle of the transition area on graph)

Zone 1: 135 – 154 bpm	(next 20% lower)
Zone 2: 155 –174 bpm	(next 20% lower)
Zone 3: 175 –185 bpm	(threshold + and - 5 bpm)
Zone 4: 186 – 95% MHR	"Race Pace"
Zone 5: 95% MHR +	

Heart Rate vs. Lactate: The lactate threshold is not the precise point where the slopes of the before and after lines intersect. It is the area in the HR vs. Lactate graph where the curve is changing direction. It is important to keep this in mind when assigning training zones. From a practical perspective, it is difficult for an athlete to exercise +/- 5 bpm in any zone, but particularly in Zone 3 and up. These values are statistical norms taken from the literature. Most athletes will conform to this pattern.

Zone 1: 1.3 – 2.0 mmol/l-1
Zone 2: 2.0 – 3.5 mmol/l-1
Zone 3: 3.5 – 5.0 mmol/l-1
Zone 4: 5.0 – 8.0 mmol/l-1
Zone 5: > 8.0 mmol/l-1

In practice, athletes use the heart rates that correspond to these lactate numbers to monitor training zones. HR at specific lactate concentrations will vary from athlete to athlete, depending on training age and fitness.

Tests for Training Effectiveness and Improvement

These tests should be done using the guidelines given above, especially with respect to health, recovery time and timing with respect to the training load.

Caution: If the heart rates in these tests are higher than the previous test, this suggests the athlete may be carrying some (residual) fatigue from either training or other life related stresses. In general, lower heart rates indicate an improved fitness level. However if there is a drastically lower heart rate caution should be exercised as this may also indicate too much fatigue.

Conconi Sub-maximal Test

The Conconi test described above can be used on a regular basis in this sub-maximal form to predict training readiness as well as to measure changes in fitness. To monitor improvement, it is only necessary to perform the test up to the 170 bpm level of intensity (first 4 points). This lowers the testing stress on the athlete considerably. Lactate can be taken if available or simply use the heart rate and speed measurements.

Scoring: Each test is plotted on the same graph to show the change from training test to training test. Provided training fatigue is not masking improvement, successive lines should move down and to the right if aerobic fitness is improving.

Bicycle Ergometer Sub-maximal Test

Equipment: A bicycle ergometer, e.g. a Monark, calibrating test cycle, which allows precise, incremental increase in resistance.

Procedure: Athlete does a 15 min. warm up with the resistance set low enough that the athlete remains in Zone 1 (<= 70% MHR) while cycling at 80 rpm. Cycle RPM is maintained at 80 rpm throughout the remainder of the test. After 15 min. the load is increased once every three minutes. The average heart rate for the last 30 sec. of each load period is recorded.

Loading sequence:
Males: 1.5kg, 2.0kg, 2.5kg, 3.0kg
Females: 1.0kg, 1.5kg, 2.0kg, 2.5kg

Scoring: Heart rates are plotted against the load. Each test is plotted to show the change from test to test. Successive lines should move down and to the right.

Lactate Monitoring – Spot Checks

In addition to using lactate in performance tests, the following are some other ways to use lactate less formally to monitor training effectiveness:

Validation of Training Zones: After performing a Conconi test to establish training zones and corresponding lactate levels, it is useful to perform spot checks on athletes while they are actually training. An athlete is given instructions to "run Zone 1 (130-145 bpm) on the 2 km loop". At the end of the loop the coach can stop the athlete, take a lactate sample and compare it to the target lactate level derived from the Conconi test. If the observed value is outside the target range the coach can instruct the athlete to speed up or slow down as appropriate.

Tracking improvement: Alternatively, using the same Zone 1, 2 km loop example, the coach can also chart change in fitness by noting the change in speed (time per loop) for the same lactate cost in successive training sessions on this 2 km loop. The athlete can record the splits with an HR monitor.

Maximal Lactate Production

The ability to produce high levels of lactate on demand can indicate improved ability to perform at high intensity. For example, early in the dry land season it is often difficult for athletes to produce high levels (10-14 mmol/l-1) of lactate in maximal roller ski efforts. As their training specificity increases later in the season, they are able to produce higher levels. The same is true for snow skiing.

Equipment: Standardized roller ski or snow track loop that takes at least 2 min. to ski.

Procedure: Athlete does a full 15 min. warm up before the first interval. Start with a 2 min. maximal effort, followed by 2 min. of active recovery, followed by second 2 min. maximal effort.
Take a lactate sample immediately after the second 2 min. effort. Athlete continues with an active recovery process for the next 15 min. Sample again at plus 1 min, plus 5 min, plus 10 min, and plus 15 min.

Scoring: Plot a graph of lactate vs. time. The peak value of the graph gives you a clear indication of the lactate production capability. The slope of the graph measures the recovery capability of the athlete. It is important that the recovery activity be carefully controlled during the time between the samples so that the protocol can be repeated in subsequent tests.

Low Lactate Levels: There can be more than one reason why an athlete is not able to produce high levels of lactate (> 8 mmols). It is up to the coach to decipher the most likely reasons through training diary evaluation and other monitoring tools before deciding on the next step in the training program. Here are some probable causes for low lactate values:

- The athlete is (still) tired from the previous training load and needs extra recovery time.
- The athlete does not have the required movement efficiency to make the muscles work hard enough to produce the lactate.
- The athlete does not have the required strength to produce the forces that would generate a lactate increase.
- The anaerobic lactic energy system is under trained or has detrained over the summer period.

Anaerobic Power Roller Skiing Test

This test evaluates upper body, lower body and combined roller ski power. It can also be used to evaluate and practice race warm-up protocols.

Equipment: Roller skis; 800m of gradual uphill or flat (public road) pavement; stop watch.

Optional equipment: Heart rate monitor, lactate analyzer, video camera

Procedure: The test is 3 x 800m at full effort:
Athletes start with a full race warm up, followed by:
1 x 800m full body skiing, fastest technique,
10 min. standardized active recovery,
1 x 800m legs-only skiing
10 min. standardized active recovery,
1 x 800m arms-only skiing,
10 min. Standardized active recovery,
(HR and lactate sample before and after each test).
15 – 20 min. additional recovery activity.

Scoring: Record the completion time for each 800m test; (starting and ending HR for each test and lactate concentration at start and end of each test).

Optional: Video analysis of each segment, post-test. Evaluate warm up routine and effect on first test).

Shooting Tests

The shooting tests described in the previous section can also be repeated periodically to monitor improvement in shooting abilities. The following tests monitor performance effectiveness.

Precision Shooting Test

See the Tests For Comparative, Sport Specific Data section above.

Registration of Shooting Combos

For tracking performance improvements and to promote intramural pride and competitiveness.

Equipment: Standard Biathlon falling plate targets or air rifle equivalents at standard distances, with standardized running, roller skiing or skiing loops as appropriate.

Procedure: Repeat on pre-determined days, weekly or bi-weekly, once biathlon-shooting (BS) training commences.
One set of four combos (P, S, P, S), with standardized interval distances, running, roller skiing or skiing as appropriate, is designated in advance, as an "official test".

Scoring: Record loop time splits, range times and shooting scores. Cumulative results for the training group are published in a ranking table. If the coach has access to historical data from previous athletes who are now successful, it is possible to establish standard values for these parameters (splits, range times, scores) and translate them into comparison measures, to give a normalized score that is a success predictor.

Summer Biathlon Competition, Running or Roller Skiing

Run as a time trial, the coach can evaluate the following:

- Running or roller skiing performance in a competition situation
- Shooting performance under competition conditions
- Combined Biathlon performance (Physical/Shooting)
- Tactical performance (from splits and shooting bouts)
- Race preparation and mental training.

As there is no "standard course" available from site to site, this test is not included in section two. The results are specific to the local training environment. However, running the time trial as an invitational competition can provide comparative data.

Equipment: Selection of roller ski equipment will influence the testing data significantly. It is strongly recommended that roller skis used for any testing give ski speeds consistent with on-snow ski speeds for a given distance (e.g. in m/s). Most importantly, athletes and coaches should record the types of skis used and the wear pattern of the wheels in order to match them as consistently as possible from test to test and year to year. Weather can also play a significant role in influencing data from roller ski tests, as large temperature fluctuations (+/- 7 to 10 degrees) and surface moisture (rain, frost) will influence ski speed. Recording of meteorological data is necessary to assist in interpreting results. Conducting these tests early in the day (e.g. between 0800 and 1000) may minimize the affects of temperature change on the track.

Distances: It is not possible to establish standard distances for roller ski or running race tests. Coaches should select the terrain and the distance such that the total time taken is close to the total time taken for a standard Sprint distance, on-snow, by the target group of athletes (in the previous season). Decrease in total time towards values close to typical on-snow podium times for key target events indicate progress and are a good prognosticator of on-snow times.

Procedure: Follow these guidelines to make the testing valid within a local training group.

- Choose testing dates that coincide with suitable points in the dry land training plan. For example, after a recovery period in the plan.
- Test at or near the same time in each training year to obtain year-to-year comparisons.
- The course must be the same each time the test is performed. Therefore choose courses that are not likely to be affected by construction/traffic/weather/etc.
- Roller ski competitions should be on courses that emphasize short, sharp up and down hills and flats. Avoid long, gradual down hills. Two shoots (P, S). Penalty loops.
- Running races of 4-6 km with moderate terrain are adequate for evaluation and will still correlate well with winter racing performance. Two shoots (P, S). Penalty loops.

PHV Monitoring Data Form

Child's Name: _____

Birth Date: _____ Today's Date: _____
(Month/Day/Year) (Month/Day/Year)

Repeated measurements should be done at the same time of day, each time. Children should be bare foot or wear thin socks, and avoid bulky clothing, bouffant hairstyles, hats or other impediments to measurement.

Equipment Required

- A sharp pencil
- A tape measure,
- Masking or other opaque tape
- A breakfast cereal box,
- A stool or chair,
- A vertical flat surface- edge of a door or a wall,
- A good bathroom weigh scale

Measure Standing Height

1. Put a strip of tape vertically on the wall or door edge at about head height.
2. Stand the child with their back to the flat surface, with their heels and head touching the surface.
3. Place the cereal box on their head, long side against the flat surface.
4. With the child looking straight ahead, mark the height on the flat surface [tape] using the underside of the box as a guide.
5. Measure the distance from the floor to the mark on the flat surface. Zero point of tape on the floor. Record the distance as height.

Standing Height: _____ cm Standing Height: _____ inch

Measure Sitting Height

1. Put a strip of tape vertically on the wall or door edge at about sitting head height.
2. Sit your child on a stool or chair. They should be sitting upright with the base of their spine flat against the flat surface, their legs together and hands by their side.
6. Place the cereal box on their head, long side against the flat surface.
7. With the child looking straight ahead, mark the height on the flat surface [tape] using the underside of the box as a guide.
8. Measure the distance from the floor to the mark on the flat surface. Zero point of tape on the floor. Record the distance as height.

Height: _____cm

Height: _____inch

9. Measure the height of the stool or chair:

Stool Height: _____ cm

Stool Height: _____ inch

10. Calculate: Sitting Height = Height – Stool Height:

Sitting Height: _____cm

Sitting Height: _____inch

Measure Weight

Weigh your child on the bathroom scales:

Weight: _____ kg

Weight: _____ lbs